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U S Fish & Wildlife Service

Recovery Plan for Upland Species of the San Joaquin Valley, California

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Recovery Plan for Upland Species of the San Joaquin Valley, California

Region 1
U. S Fish and Wildlife Service
Portland, Oregon

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1998

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Drawing of a San Joaquin kit fox by Kristina Bocchini (based on photo © by B. Moose Peterson)

This Recovery Plan is dedicated
to the memory of
Suzanne N. Nelson
Wildlife Biologist
San Joaquin Valley Endangered Species Recovery Program
October 1992–January 1996

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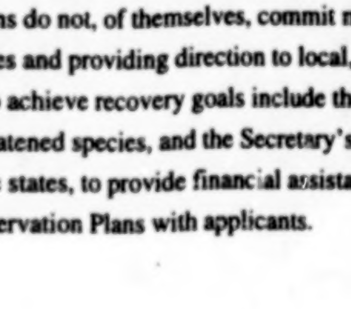
GUIDE TO RECOVERY PLAN ORGANIZATION

This recovery plan provides individual species accounts for all of the 34 species covered. Recovery strategies are organized by geographic area (or ecosystem area) whenever possible, thereby combining recovery tasks for multiple species. Because of the length and complexity of this recovery plan, an appendix is provided listing the common name and scientific name of all plants and animals mentioned in the plan (Appendix A). Technical terms are italicized and defined at their first use in the text and included in a glossary of technical terms (Appendix B).

U.S. FISH & WILDLIFE SERVICE'S MISSION IN RECOVERY PLANNING

Section 4(f) of the Endangered Species Act (Act) of 1973, as amended, directs the Secretary of the Interior and the Secretary of Commerce to develop and implement recovery plans for species of animals and plants listed as endangered or threatened unless such plans will not promote the conservation of the species. The Fish and Wildlife Service and the National Marine Fisheries Service have been delegated the responsibility of administering the Act. Recovery is the process by which the decline of an endangered or threatened species is arrested or reversed, and threats to its survival are neutralized, so that its long-term survival in nature can be ensured. The goal of this process is the maintenance of secure, self-sustaining wild populations of species with the minimum necessary investment of resources. A recovery plan delineates, justifies, and schedules the research and management actions necessary to support recovery of a species. Recovery plans do not, of themselves, commit manpower or funds, but are used in setting regional and national funding priorities and providing direction to local, regional, and State planning efforts. Means within the Endangered Species Act to achieve recovery goals include the responsibility of all Federal agencies to seek to conserve endangered and threatened species, and the Secretary's ability to designate critical habitat, to enter into cooperative agreements with the states, to provide financial assistance to the respective State agencies, to acquire land, and to develop Habitat Conservation Plans with applicants.



DISCLAIMER

Recovery plans delineate reasonable actions that are believed to be required to recover and protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service ***only*** after they have been signed as ***approved***. Approved recovery plans are subject to modification as dictated by new findings, change in species status, and the completion of recovery tasks.

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thrasher

EXECUTIVE SUMMARY

Introduction: This recovery plan covers 34 species of plants and animals that occur in the San Joaquin Valley of California. The 11 listed species include five endangered plants (California jewelflower, palmate-bracted bird's-beak, Kern mallow, San Joaquin woolly-threads, and Bakersfield cactus), one threatened plant (Hoover's woolly-star), and five endangered animals (giant kangaroo rat, Fresno kangaroo rat, Tipton kangaroo rat, blunt-nosed leopard lizard, and San Joaquin kit fox). In addition, 23 candidates or species of concern are addressed. The plants include lesser saltscale, Bakersfield smallscale, Lost Hills saltbush, Vasek's clarkia, Temblor buckwheat, Tejon poppy, diamond-petaled California poppy, Comanche Point layia, Munz's tidy-tips, Jared's peppergrass, Merced monardella, Merced phacelia, and oil neststraw; and the animals include Ciervo aegialian scarab beetle, San Joaquin dune beetle, Doyen's dune weevil, San Joaquin antelope squirrel, short-nosed kangaroo rat, riparian woodrat, Tulare grasshopper mouse, Buena Vista Lake shrew, riparian brush rabbit, and San Joaquin Le Conte's thrasher.

The majority of these species occur in *arid* grasslands and scrublands of the San Joaquin Valley and the adjacent foothills and valleys. The riparian woodrat and riparian brush rabbit inhabit forested river corridors of the eastern San Joaquin Valley. Conversion of habitat to agricultural, industrial, and urban uses has eliminated these species from the majority of their historic ranges. The remaining natural communities (generally less than 5 percent of historical values) are highly fragmented, and many are marginal habitats in which these species may not persist during catastrophic events such as drought or floods. Moreover, natural communities have been altered permanently by the introduction of nonnative plants, which now dominate in many of the remaining undeveloped areas.

Recovery Objectives: The ultimate goal of this recovery plan is to delist the 11 endangered and threatened species and ensure the long-term conservation of the 23 candidates and species of concern. An interim goal is to reclassify the endangered species to threatened status.

Ecosystem Approach and Community-level Strategy for Recovery: This plan presents both an ecosystem approach to recovery and a community-level strategy for recovery. The latter is appropriate because most of the listed and candidate species and species of concern co-occur in the same natural communities and are interdependent. By protecting entire communities, the likelihood of successful recovery for listed species is increased, and ensuring the long-term conservation of candidates and species of concern is possible. Of necessity, this community-level strategy is shaped by the realities of existing habitats; available information on biology, distribution, and population statuses of featured species; and the current and anticipated biological and social processes that will affect both remnant natural communities and areas subject to intensive human use, within the human-dominated landscape (i.e., ecosystem) of the San Joaquin Valley.

An ecosystem approach to recovery in the San Joaquin Valley recognizes not only the common origins and interdependencies of the remnant natural communities, but also the fact that the entire region today is a landscape dominated by human activities. Those activities, while defining and shaping the current ecosystem, have often had a fragmenting rather than unifying effect. Thus, recovery also is dependent on the cooperation and collaboration of the various stakeholders, in the Valley ecosystem, which include private landowners, local governments and citizens, and State and Federal agencies.

The six key elements that compose this ecosystem approach and community-level recovery strategy are described below.

1. **Recovery criteria**

   The community-level approach facilitates recovery but does not negate the need to consider the requirements of each species. Thus, individual recovery criteria are presented for each of the 11 listed species covered by this plan to track their progress towards recovery and to ensure that all of their recovery needs are addressed.

   Separate criteria are given in the recovery plan for downlisting 10 species from endangered to threatened, for delisting those 10 species plus 1 threatened species, and for achieving long-term conservation of the 23 species that are not currently listed. Elements common to the recovery criteria of most listed species include:

- protection from development and incompatible uses of the habitat of specified populations representing the full range of genetic and geographic variation in the species,
- development and implementation of appropriate habitat management plans for each species and area identified for protection, and
- self-sustaining status of the specified populations.

The protection strategies for most candidates and species of concern are based on the assumption that if populations remain in habitat remnants throughout a species' historical range, are secure from threats, and are not declining, formal listing may not be necessary.

2. Habitat protection

Considering that habitat loss is the primary cause of species endangerment in the San Joaquin Valley, a central component of species recovery is to establish a network of conservation areas and reserves that represent all of the pertinent terrestrial and riparian natural communities in the San Joaquin Valley. Habitat protection does not necessarily require land acquisition or easement. The most important aspect of habitat protection is that land uses maintain or enhance species habitat values. Elements 4-6 of the recovery strategy address this issue.

Existing natural lands, occupied by the covered species, are targeted for conservation in preference to unoccupied natural land or retired farmland. This greatly reduces or eliminates the need for expensive and untested restoration work to make the land suitable for habitation by these species. Many of the covered species are concentrated in the natural communities that persist in the San Joaquin Valley. The recommended approach is to protect land in large blocks whenever possible. Large blocks minimize edge effects, increase the likelihood that ecosystem functions will remain intact, and facilitate management.

Another recommendation of the plan is that, whenever possible, blocks of conservation lands should be connected by natural land or land with compatible uses to allow for movement of species between blocks. Linkages are proposed both on the floor of the San Joaquin Valley and in foothills along the margins of the Valley. Few Valley floor linkages exist at this time; restoration of continuous corridors or islands of suitable vegetation that can act as "stepping stones" will be necessary to provide movement corridors. Natural land remaining along the fringes of the San Joaquin Valley will provide both habitat and linkages.

Smaller specialty reserves also are a necessary part of the proposed habitat protection network. They are important for recovery of certain species with highly restricted geographic ranges or specialized habitat requirements. These reserves may be small areas surrounded by developed land, or they may be portions of larger conservation areas that require special management.

3. Umbrella and keystone species

In formulating the community-level strategy, greater emphasis was placed on two groups of species due to their pivotal roles in either conservation (*umbrella species*) or ecosystem dynamics (*keystone species*).

The San Joaquin kit fox occurs in nearly all the natural communities used by other species featured in this plan, but these others are much more restricted in their choice of habitats. The broad distribution and requirement for relatively large areas of habitat means conservation of the kit fox will provide an umbrella of protection for many other species that require less habitat. Therefore, the San Joaquin kit fox is an umbrella species for purposes of this recovery plan. Many of its needs are given higher priority in recovery actions at the regional level (i.e., the ecosystem level) than those of other species because it is one of the species that will be hardest to recover; fulfilling the fox's needs also meets those of many other species.

Protection of keystone species is a high priority because they provide important or essential components of the biological niche of some other listed and candidate species. The giant kangaroo rat and, to a lesser extent, the Fresno, short-nosed, and Tipton kangaroo rats are keystone species in their communities. Burrowing by giant kangaroo rats modifies the surface topography of the landscape and changes the mineral composition of the soil. Their burrows provide refuges and living places for many small animals, including blunt-nosed leopard lizards and San Joaquin antelope squirrels. The areas over and around their burrows provide a favored microhabitat for the growth of California jewelflower and San Joaquin woolly-threads. Giant kangaroo rats are the most abundant mammal in their community, and are the favored prey of San Joaquin kit foxes and many other predators. The Fresno, short-nosed, and Tipton kangaroo rats have similar but less dramatic roles in their communities.

4. Monitoring and research program

This recovery plan has been developed based on the best scientific information currently available. However, many important aspects of species biology and management have not yet been studied. Thus, continued research, in conjunction with *adaptive management* (element #5), is a crucial component of this plan. Recovery criteria and tasks must be reevaluated for each species as research is completed.

Primary information needs for the species featured in this plan and the ecosystem as a whole are:

- habitat management research,
- habitat and species restoration trials,
- surveys to determine species distributions,
- biosystematic and population genetics studies,
- reproductive and *demographic* studies,
- population censusing and monitoring, and
- studies of pesticide effects on the featured species and their associated species.

5. Adaptive management

In most cases, active management of the land is necessary to maintain and enhance species habitat values. However, management strategies have not been investigated for most species. Management research (element #4) may take many years to complete, while listed species populations continue to decline. The only practical approach is adaptive management, where some type of management is applied, population responses are monitored, the outcome is evaluated, and management is readjusted accordingly. This process should continue until definitive research is completed or self-sustaining populations are achieved. Unless scientific data or credible evidence point to the contrary, the recommended initial management strategy for each area that is occupied by listed species is to continue existing land uses at current levels.

6. Economic and social considerations

This plan proposes six tactics to reduce the costs of recovery, the impact of recommended actions on the local economy, and the constraints placed on citizens of the San Joaquin Valley:

- Focusing recovery, to the maximum extent possible, on lands already in public or conservation ownership,
- Encouraging continuation of traditional land uses, such as seasonal livestock grazing, oil production, hunting, and wildland recreation, when compatible with listed species management needs,
- Targeting agricultural land that must be retired, due to drainage problems or lack of irrigation water, for restoration to provide linkages or additional habitat for listed species,
- Developing a safe harbor program as an incentive for landowners to maintain or create endangered species habitat on their property,
- Developing other positive incentives, especially economic, for conservation, and
- Tying, as closely as possible, the habitat protection network to local and regional conservation planning efforts, including habitat conservation plans.

Implementation Participants: Although the U.S. Fish and Wildlife Service has the statutory responsibility for implementing this recovery plan, and only Federal agencies are mandated to take part in the effort, the participation of a variety of groups, in both initial plan implementation and the subsequent adaptive management process, is important to successful recovery. Thus, the plan recommends the establishment of a regional, cooperative public/private recovery plan implementation team to enlist the participation of all stakeholder groups and interested parties. This group would develop a participation plan, coordinate education and outreach efforts, including community participation in research and information gathering when appropriate, assist in developing economic incentives for conservation and recovery, ensure that adaptive management is practiced, and define other recovery and management tasks as necessary.

Total Estimated Cost of Recovery[1]:

Priority 1 tasks: $19,200,500

Priority 2 tasks: $17,253,500

Priority 3 tasks: $3,650,000

There are likely to be additional costs that are yet to be determined.

Date of Recovery: Because recovery is defined in relation to a climatological cycle for most species covered in this recovery plan, the date of recovery is anticipated for most listed species to be approximately 20 years.

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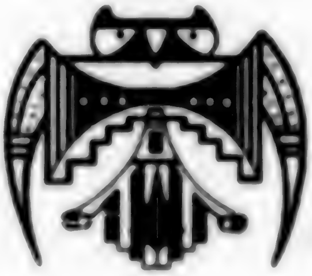
[1] Priority 1—An action that must be taken to prevent extinction or prevent the species from declining irreversibly in the foreseeable future.
Priority 2—An action that must be taken to prevent a significant decline in species population or habitat quality, or some other significant negative impact short of extinction.
Priority 3—All other actions necessary to meet recovery objectives.



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I. INTRODUCTION

The San Joaquin and Sacramento Valleys together form the great Central Valley of California, an enormous flat-bottomed trench rimmed by mountains (Figure 1). The Valley floor is 690 kilometers (430 miles) long and covers about 6,000,000 hectares (15 million acres). The San Joaquin Valley's watershed encompasses approximately 20 percent of the land area of the State (Colliver 1993). Its floor below about the 152-meter (500-foot) contour measures approximately 3.44 million hectares (8.5 million acres) and extends about 415 kilometers (258 miles) north-south. West of the Valley proper, hills below about 915 meters (3,000 feet) and high plains support natural communities in common with much of the Valley floor.

The San Joaquin Valley floor is occupied by four urban areas each with populations numbering from 200,000 to more than 500,000 people—Stockton, Modesto, Fresno, and Bakersfield—and eight smaller urban centers each with between 50,000 and 150,000 people: Lodi, Tracy, Manteca, Turlock, Merced, Madera, Hanford-Lemoore, and Visalia. By 1979, nearly all the Valley floor and many of the flatter upland areas were urbanized or converted to cultivated cropland. Less than 60,700 hectares (150,000 acres), or less than 5 percent, of the Valley floor remains uncultivated. Most of the remaining undeveloped land is in the foothills on the Valley's perimeter. Significant portions of the land not cultivated or urbanized have been developed for petroleum extraction, strip-mined for gypsum and clay, or occupied by roads, canals, airstrips, oil-storage facilities, pipelines, and evaporation and percolation basins.

A. Overview

1. Species Represented and Biotic Communities

Listed Species.—This recovery plan covers 11 species federally-listed as endangered or threatened (Table 1). Five plants *endemic* to arid shrublands and grassland communities of the San Joaquin Valley are endangered or threatened. Of the five, the California jewelflower occupied a wide range of elevation and community types but is now very restricted in distribution. Bakersfield cactus is the only desert-adapted succulent plant within the San Joaquin Biotic Region (Williams and Kilburn 1992). A sixth endangered plant covered in this recovery plan, palmate-bracted bird's beak, mostly occupies alkali sink and chenopod scrub communities; its range extends into similar communities in the Sacramento Valley.

Of the five federally-listed endangered species of animals included in this recovery plan, two species have formerly-approved recovery plans. A recovery plan for the blunt-nosed leopard lizard was approved in 1980 (U.S. Fish and Wildlife Service [USFWS] 1980*a*) and a revised recovery plan was approved in 1985 (USFWS 1985*a*). The San Joaquin kit fox recovery plan was approved in 1983 (USFWS 1983). Thus, this recovery plan represents a revision of the recovery plans for these two species.

Of these 11 federally-listed plant and animal species, critical habitat has been designated only for the Fresno kangaroo rat. See the species account for the Fresno kangaroo rat for a description of its critical habitat.

Associated Candidates and Species of Concern.—Thirteen plant species of concern that occur in desert scrub, grassland, and seasonal *playa* habitats with existing geographic ranges within the region are fully considered in this recovery plan (Table 1). Three mammals that are candidates for Federal listing, and four mammal species of concern and one avian species of concern also are featured in this recovery plan (Table 1). The Buena Vista Lake shrew is the only species to be included that was historically most common in wetlands. It is included here because all of its extant habitat and potential habitat is included within the habitats of the listed species that use alkali sink and associated communities. Two riparian species also are included, the riparian brush rabbit and riparian woodrat. Though their habitats are distinct from those of the other featured species, they are the only two riparian species whose ranges are confined to the San Joaquin Valley. It was expedient to include them here. Three insect species of concern confined to interior sand dune communities and loose sandy soils in other grassland and shrubland communities also are featured in this plan (Table 1). Approximately 61 other plants of concern have geographic distributions partly or wholly within the San Joaquin Valley planning region, but either are confined to wetlands and vernal pools or range into the Sierra

TABLE 1. *Federally-Listed Species, Candidates and Species of Concern Included in this Recovery Plan.*

Species	Status [a]	Recovery Priority [b]	Federal Listing Date & Reference; State Listing Date	Community Associations
California jewelflower *(Caulanthus californicus)*	FE, CE	2	19 Jul 1990, 55 Fed. Reg. 29370; Jan 1987	grasslands, subshrub scrub, chenopod scrub, juniper woodland
palmate-bracted bird's-beak *(Cordylanthus palmatus)*	FE, CE	2c	31 Jul 1986, 51 Fed. Reg. 23765; May 1984	Valley and foothill grasslands, chenopod scrub
Kern mallow *(Eremalche kernensis)*	FE	2	19 Jul 1990, 55 Fed. Reg. 29370	chenopod scrub, grassland
Hoover's woolly-star *(Eriastrum hooveri)*	FT	2	19 Jul 1990, 55 Fed. Reg. 29370	chenopod scrub, grassland
San Joaquin woolly- threads *(Lembertia congdonii)*	FE	1	19 Jul 1990, 55 Fed. Reg. 29370	grassland, chenopod scrub, subshrub scrub
Bakersfield Cactus *(Opuntia basilaris var. treleasei)*	FE, CE	3c	19 Jul 1990, 55 Fed. Reg. 29370; Jan 1990	sandy soils, arid grassland, chenopod scrub
giant kangaroo rat *(Dipodomys ingens)*	FE, CE	2c	5 Jan 1987, 52 Fed. Reg. 283; 2 Oct 1980	grassland, chenopod scrub, subshrub scrub
Fresno kangaroo rat *(Dipodomys nitratoides exilis)*	FE, CE	3c	30 Jan 1985, 50 Fed. Reg. 4222; 27 June 1971(rare), 2 Oct 1980 (endangered)	Relictual Interior Dune Grassland, other grasslands, chenopod scrub, alkali sink
Tipton kangaroo rat *(Dipodomys nitratoides nitratoides)*	FE, CE	3c	8 Jul 1988, 53 Fed. Reg. 25608; 11 Jun 1989	Relictual Interior Dune Grassland, chenopod scrub, alkali sink, other grasslands
blunt-nosed leopard lizard *(Gambelia sila)*	FE, CE	2c	11 Mar 1967, 32 Fed. Reg. 4001; 27 Jun 1971	grassland, chenopod scrub, alkali sink, subshrub scrub
San Joaquin kit fox *(Vulpes macrotis mutica)*	FE, CT	3c	11 Mar 1967, 32 Fed. Reg. 4001; 27 Jun 1971	grasslands, chenopod scrub, alkali sink, subshrub scrub, oak woodland, agriculture
lesser saltscale *(Atriplex minuscula)*	SC			chenopod scrub, grassland, alkaline playas
Bakersfield smallscale *(Atriplex tularensis)*	SC, CE		Jan 1987	alkali sink, chenopod scrub
Lost Hills saltbush *(Atriplex vallicola)*	SC			alkali sink, chenopod scrub
Vasek's clarkia *(Clarkia tembloriensis ssp. calientensis)*	SC			Valley and foothill grassland
Temblor buckwheat *(Eriogonum temblorense)*	SC			barren clay, shale soils, grassland, subshrub scrub
Tejon poppy *(Eschscholzia lemmonii ssp. kernensis)*	SC			grasslands
diamond-petaled California poppy *(Eschscholzia rhombipetala)*	SC			clay soils, grasslands
Comanche Point layia *(Layia leucopappa)*	SC			chenopod scrub, grasslands

Table 1 *(continued). Federally-Listed Species, Candidates and Species of Concern Included in this Recovery Plan.*

Species	Status [a]	Recovery Priority [b]	Federal Listing Date & Reference; State Listing Date	Community Associations
Munz's tidy-tips *(Layia munzii)*	SC			alkaline clay soils, grasslands, chenopod scrub
Jared's peppergrass *(Lepidium jaredii)*	SC			alkali sink, grasslands, chenopod scrub
Merced monardella *(Monardella leucocephala)*	SC			sandy soils, grasslands
Merced phacelia *(Phacelia ciliata var. opaca)*	SC			clay soils, grasslands
oil neststraw *(Stylocline citroleum)*	SC			clay soils, chenopod scrub
Ciervo aegialian scarab beetle *(Aegialia concinna)*	SC			Relictual Interior Dune Grassland, chenopod scrub in sandy soil
San Joaquin dune beetle *(Coelus gracilis)*	SC			Relictual Interior Dune Grassland, chenopod scrub
Doyen's dune weevil *(Trigonoscuta sp.)*	SC			Relictual Interior Dune Grassland, chenopod scrub
San Joaquin antelope squirrel *(Ammospermophilus nelsoni)*	SC, CT		2 Oct 1980	grassland, chenopod scrub, subshrub scrub, alkali sink
short-nosed kangaroo rat *(Dipodomys nitratoides brevinasus)*	SC			grassland, chenopod scrub, subshrub scrub, alkali sink
riparian woodrat *(Neotoma fuscipes riparia)*	PE			riparian forest and scrub
Tulare grasshopper mouse *(Onychomys torridus tularensis)*	SC			grassland, chenopod scrub, subshrub scrub, alkali sink
Buena Vista Lake shrew *(Sorex ornatus relictus)*	C			marsh, riparian
riparian brush rabbit *(Sylvilagus bachmani riparius)*	PE, CE		29 Apr 1994	riparian forest and scrub
San Joaquin LeConte's thrasher *(Toxostoma lecontei lecontei)*	SC			chenopod scrub, subshrub scrub

[a] FE & FT—Federal Endangered and Threatened; CE & CT—California Endangered and Threatened; PE—proposed endangered; C—Federal candidates for listing; SC—species of concern (species not presently candidates for listing) (USFWS 1996).

[b] Recovery Priority—
See Appendix C for how recovery priorities are established for listed species.

Nevada foothills or Delta and East Bay Regions at the north end of the Valley, and are not covered by this plan. Additionally, there are other listed and candidate species which occur within the San Joaquin Valley which are not covered in this plan. These species are either covered under existing recovery plans or will be covered by a recovery plan in the future. The federal status, species distribution, and the availability of a recovery plan are listed in Appendix D.

Biotic Communities.—Major types of natural plant communities in the San Joaquin Valley below the 500-meter (1,500-foot) contour include herbaceous (grasslands, vernal pools, and marshes), shrublands, woodlands, and riparian forests (Figure 2; Küchler 1977, Holland 1986, Griggs et al. 1992). Above that elevation, vegetation grades through woodlands and into evergreen forests. On the west, grassland and shrub communities extend to between 600 and 900 meters (2,000 and 3,000 feet).

Although biotic communities comprise both animals and plants, communities typically are named on the basis of the dominant plant species or site characteristics. Several classification systems have been proposed for biotic communities in California, but none is universally accepted. Specific community names that are capitalized herein correspond to those described by Holland (1986) and Griggs et al. (1992). The equivalent names under alternate systems are summarized by Mayer and Laudenslayer (1988). Many of the natural communities in the San Joaquin Valley are considered rare (Holland 1986, Griggs et al. 1992), irrespective of the presence of rare species. Certain recovery actions for endangered and threatened species also will contribute to the conservation of the rare communities they inhabit. Plant communities discussed in this recovery plan are described below. See Table 1 for the featured species that occur in these plant communities.

Grasslands are dominated by perennial or annual grasses, but the associated *forbs* (broad-leaved herbs) often are conspicuous because of their showy flowers. General terms that have been used for grasslands in the San Joaquin Valley include California prairie (Küchler 1977) and Valley and Foothill Grassland (Holland 1986). The featured species in this recovery plan occur in the following grassland communities: Nonnative Grassland, Pine Bluegrass Grassland, Relictual Interior Dune Grassland, Valley Needlegrass Grassland, and Valley Sacaton Grassland. Some of the featured species may range through areas that consist of a mosaic of grasslands and vernal pools, particularly Northern Claypan Vernal Pools and Northern Hardpan Vernal Pools.

A marsh is an herbaceous wetland community. The dominant plants (sedges, rushes, and cattails) are related to grasses. A general name for freshwater marshes of the San Joaquin Valley is tule marsh (Küchler 1977), which includes Cismontane Alkali Marsh, Valley Freshwater Marsh, and Vernal Marsh. Valley Freshwater Marsh intergrades with Coastal Brackish Marsh in the Sacramento-San Joaquin Delta.

San Joaquin Valley shrublands often are referred to as *scrub* because they are dominated by shrubs less than 2 meters (6 feet) tall. In scrub communities the actual cover of shrubs may be dense or sparse, and the ground cover often consists of grasses and forbs typical of grassland communities. In the San Joaquin Valley, scrubs occur in alkali sinks, on alluvial fans, on dune remnants, in riparian areas, and in arid uplands.

Alkali sinks are drainage basins that have soils high in soluble salts, which may or may not be alkaline (Twisselmann 1967). These basins are dominated by *halophytes*, i.e., plants tolerant of alkaline and saline soils. *Playas* (shallow, temporary lakes) may form in alkali sinks during periods of heavy rainfall. Alkali sinks in the San Joaquin Valley typically support scrub plant communities such as Alkali Playa, *Haplopappus* Shrubland, and Valley Sink Scrub.

Alluvial fans are fan-shaped areas of soil deposited by mountain streams where they enter valleys or plains. In the San Joaquin Valley, alluvial fans typically support saltbush scrub, which is one of several plant assemblages dominated by common saltbush (*Atriplex polycarpa*) or spiny saltbush (*A. spinifera*). These include Interior Coast Range Saltbush Scrub, Sierra-Tehachapi Saltbush Scrub, and Valley Saltbush Scrub. A type of saltbush scrub also may occur on sandy deposits surrounding historical lake beds, where it is termed the Relictual Interior Dunes community. *Chenopod* scrub is a general term for shrublands that are dominated by plants in the goosefoot family (Chenopodiaceae); in the San Joaquin Valley this includes the various saltbush scrubs, Alkali Playa, and Valley Sink Scrub. Alkali Meadow is a transitional community that occurs at the bottom of alluvial fans; it comprises a mixture of species characteristic of alkali sinks, grasslands, marshes, and riparian forests.

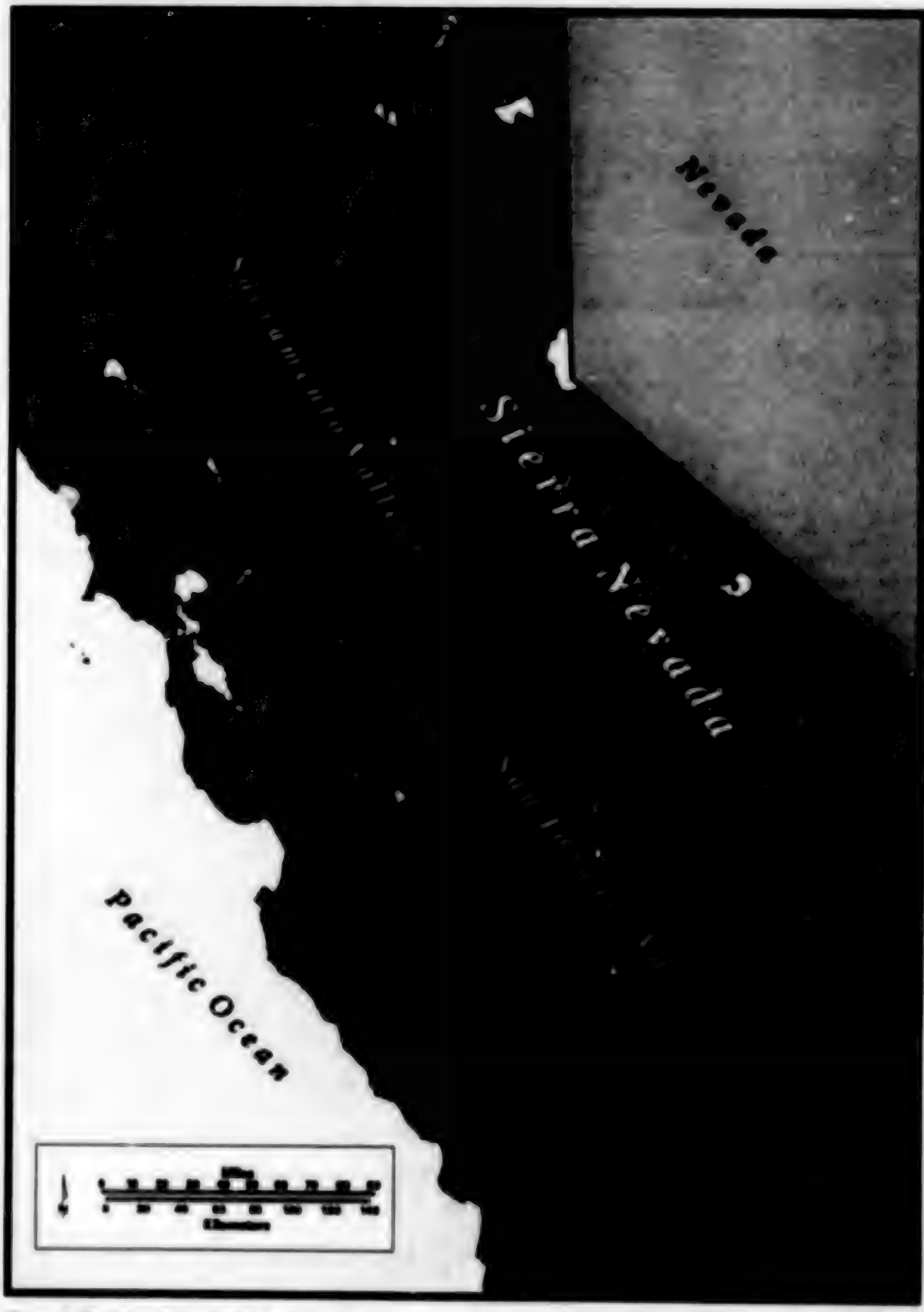


Figure 1. The Great Central Valley of California.

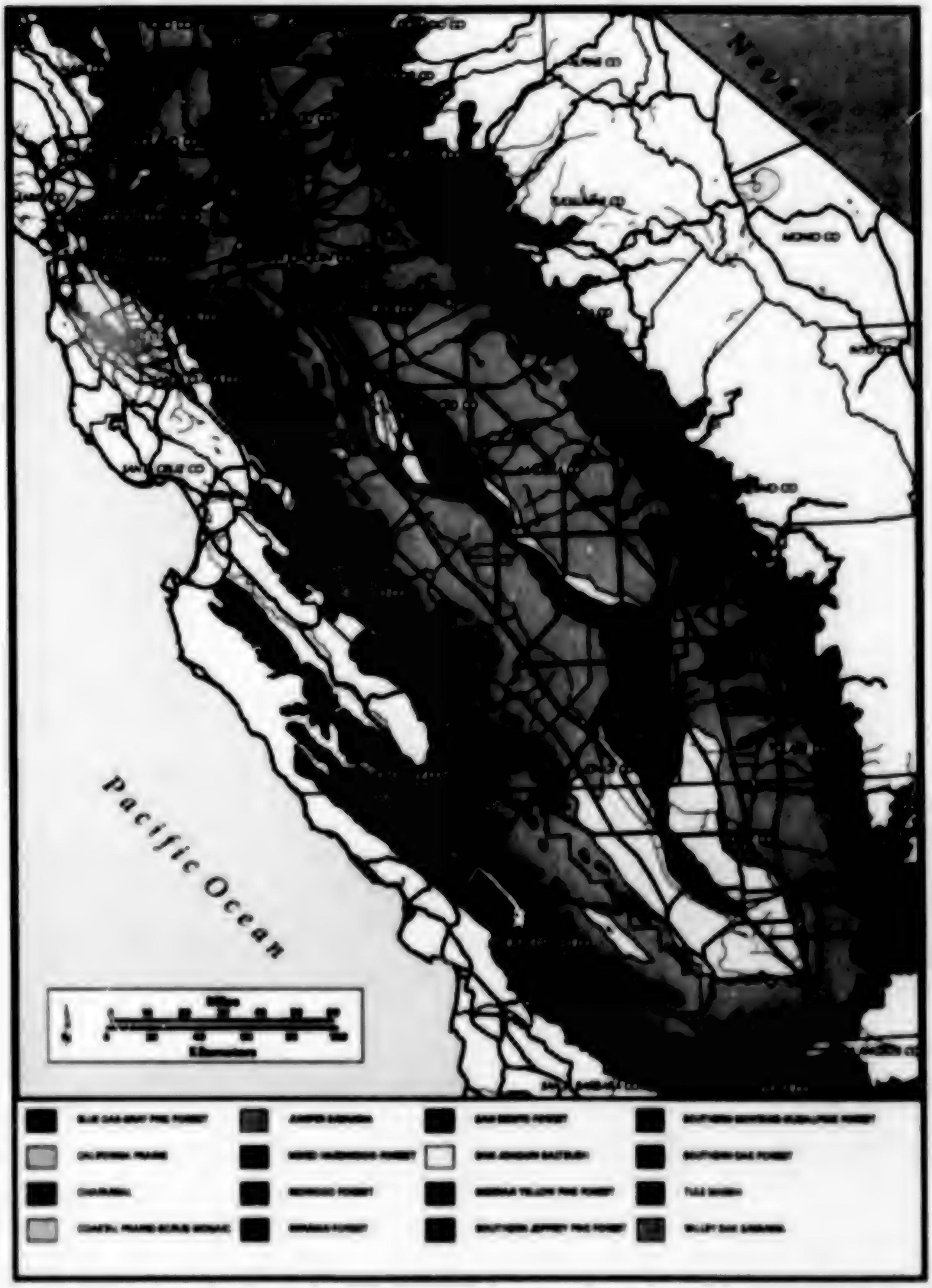


Figure 2. *Map of historical natural vegetation of central California, based on Kuchler (1977).*

Riparian scrubs occur along rivers and streams and may intergrade with riparian forests. The general name Great Valley Riparian Scrub includes several community types dominated by different shrub species, including Buttonbush Scrub, Elderberry Savanna, Great Valley Mesquite Scrub, and Great Valley Willow Scrub. Intermittent Stream Channels also are riparian but have a different shrub composition than do the channels of permanent streams.

Other scrubs that occur in arid upland areas of the San Joaquin Valley and adjacent high plains include Upper Sonoran Subshrub Scrub and chaparrals. *Subshrubs* are perennial plants that are woody only at the base, such as California buckwheat (*Eriogonum fasciculatum*) and matchweed (*Gutierrezia californica*). However, Upper Sonoran Subshrub Scrub also includes true shrubs such as California ephedra (*Ephedra californica*) and bladderpod (*Isomeris arborea*). Chaparrals are characterized by evergreen shrubs and occur most often in the outer coast ranges. Small patches have been mapped in the hills surrounding the San Joaquin Valley (Küchler 1977), but none provide habitat for the featured species in this recovery plan.

Both woodlands and forests are dominated by trees. However, trees are spaced more distantly in woodlands than in forests and do not form a solid canopy. Woodlands are characteristic of the foothills surrounding the San Joaquin Valley and also occur in the transition zones between riparian forest and grassland. Woodlands may be named on the basis of the most common trees (e.g., oak woodland, juniper woodland) or on their location (e.g., foothill woodlands, riparian woodlands). *Cismontane* woodlands are those that occur west of the Sierra Nevada crest. Woodlands in the region covered by this recovery plan include Blue Oak Woodland, Cismontane Juniper Woodland and Scrub, and Valley Oak Woodland.

Forests in the Great Central Valley consist of broad-leaved, deciduous trees and occur along rivers and streams. Shrubs, vines, and tree seedlings typically create a dense understory. A general term for this forest type is Valley riparian forest. Specific community names include Great Valley Cottonwood Riparian Forest, Great Valley Mixed Riparian Forest, and Great Valley Valley Oak Riparian Forest.

Any division of vegetation into community types must be somewhat arbitrary because communities often intergrade, rather than having identifiable boundaries. The intergradation of plant communities leads to some discrepancies regarding their proper classification. Thus, Holland (1986) included Alkali Meadow and Alkali Playa with the herbaceous communities even though both include shrubs. He classified Great Valley Mesquite Scrub as a riparian plant community, but Twisselmann (1967) considered it to be characteristic of alkali sinks. Communities also may occur in *mosaics*, which are interspersed patches of vegetation dominated by different species. Plants and animals may be restricted to particular *microhabitats*, which are localized areas with unique conditions due to small-scale variations in topography, soil characteristics, drainage patterns, and other physical features of the landscape. Thus, habitat descriptions for the rare and endangered species in this recovery plan are to some extent generalizations, which take into account the range of communities in which each species occurs.

The San Joaquin Valley shares much of its unique biota with the Sacramento Valley. Most of the Central Valley's *endemism* (species restricted in occurrence) is associated, in order of numbers, with extreme aridity, vernal pools, and wetlands. Among vascular plants, endemism is mostly associated with vernal pools (14 species), extreme aridity (8 species), and alkaline soils (6 or more species). Of the 44 endemic plants of the Central Valley, 26 are shared by the 2 regions, 14 are San Joaquin Valley endemics, and only 4 are confined to the Sacramento Valley. Of the 28 species and subspecies of endemic mammals, reptiles, and amphibians in the Central Valley, 16 are associated with arid grassland and shrubland communities in the San Joaquin Valley, and only 3 are confined to the Sacramento Valley (Bradford 1992, Williams and Kilburn 1992). More endemic vertebrate species co-occur in the San Joaquin Valley than anywhere comparable in the continental United States.

2. Reasons for Decline and Threats to Communities

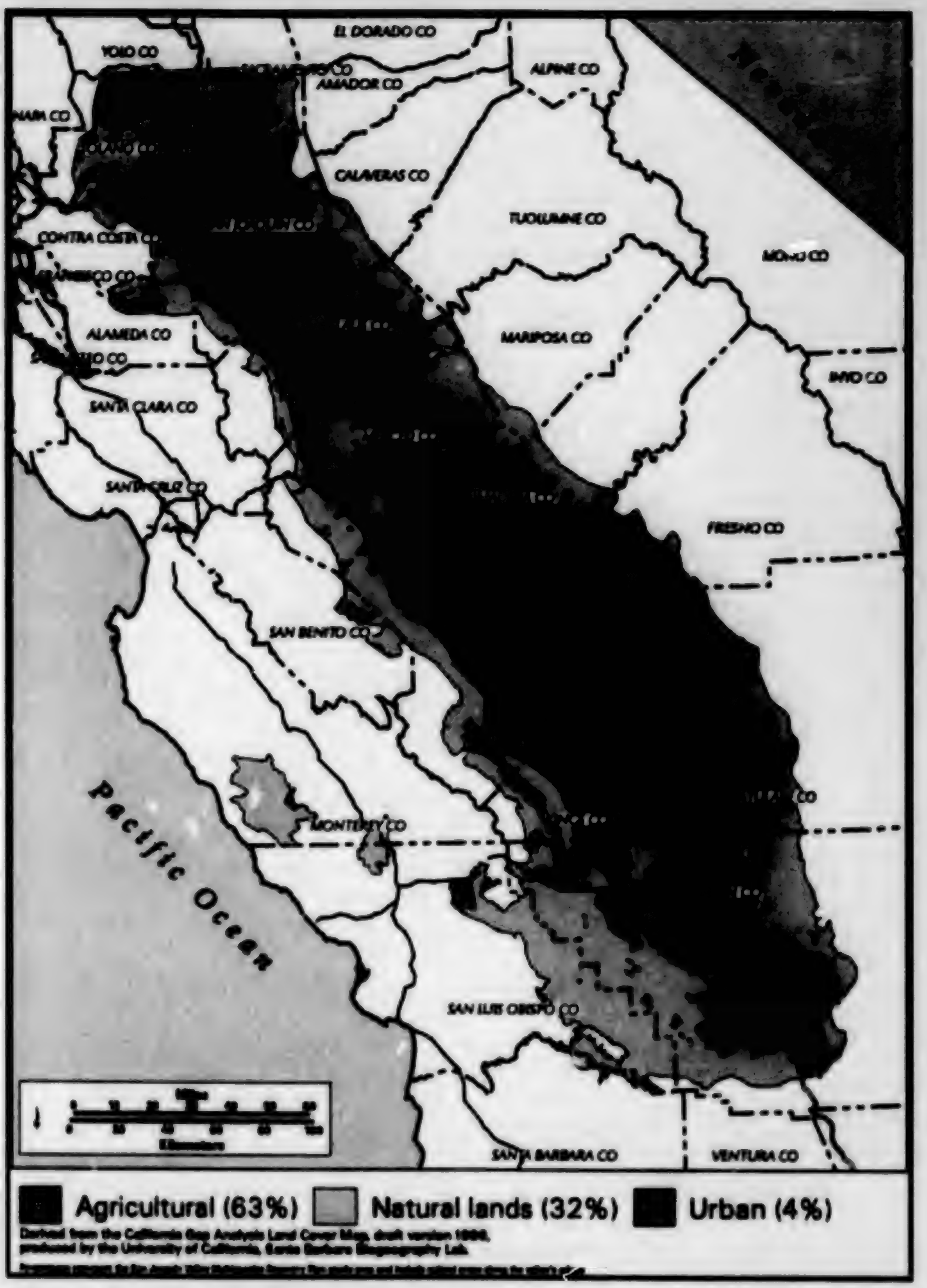
Loss and degradation of natural communities due to agriculture, urbanization, livestock grazing, water impoundment and diversion, historical predator and pest control, and other human activities have jeopardized nearly all the unique biota of the Valley below the woodland belts, and are the major causes of endangerment of the state and federally listed species (Figure 3). The delta freshwater marshes and the vast tule marshes of the Valley are nearly gone. Of the approximately 2,110,257 hectares (5,214,539 acres) of land in the southern San Joaquin Valley region (including the Carrizo Plain Natural Area and most of the Tulare Basin below the woodland belts) studied by the California Energy Commission, only 324 hectares (800 acres) of degraded wetlands were found by 1989 (Spiegel and Anderson 1992). Over 40,468 hectares (100,000 acres) of seasonal wetlands are found farther north in the San Joaquin Basin, mostly in Fresno and Merced Counties. The grassland and vernal pool communities have been reduced mostly to narrow piedmont strands, fringing the Valley floor, and their native species have been largely displaced by exotic species of weedy annual grasses and forbs. Of the original 400,000 hectares (about 1 million acres) or more of riparian communities in the Central Valley, less than 10 percent existed in 1979, mostly located in the Sacramento Valley (Warner 1979). Water diversions, stream channelization, and clearing and cultivation of riparian communities all have played roles in loss of riparian communities. Of those remaining today, most are highly degraded in quality and support few or none of their characteristic species. Extant riparian communities in the San Joaquin Valley consist of less than 2,800 hectares (7,000 acres) of narrow, degraded stands along channelized streams. Only about 269 hectares (665 acres) of relatively mature riparian forest with a well-developed understory of herbs and shrubs are found in two parks and one preserve in the San Joaquin Valley (Williams and Kilburn 1984).

Loss and degradation of natural communities in the region due to conversion to irrigated cropland have continued at much slower rates since about 1986, but still pose new threats to many additional species (Williams and Kilburn 1992, USFWS 1994*a*). The greatest new threats are to the biota of grassland and vernal pool communities along the eastern and northwestern edges of the Valley, where urbanization, ranchette developments, wind energy developments, and cultivation are collectively causing destruction of natural communities at an increasing pace.

3. Conservation Efforts at the Community Level

Past Conservation Measures.—Specific and important general conservation measures for one or a few species are briefly mentioned in individual species accounts. Highlighted here and in Table 2 are the most significant large-scale natural community acquisitions and habitat conservation planning efforts involving the species covered in this document. The California Energy Commission has conducted two important large-scale natural community and species surveys. The first was The Southern San Joaquin Valley Ecosystem Protection Program (Anderson et al. 1991, Spiegel and Anderson 1992), wherein surveys of quarter-sections of natural lands in most of the Tulare Basin were made. Later, California Energy Commission conducted quarter-section surveys on the Carrizo Plain Natural Area with funding provided by the U.S. Bureau of Land Management (USBLM; Kakiba-Russell et al. 1991). These two programs have collectively provided more information on extant biotic communities and habitat distribution and quality for listed species than all others combined. The California Energy Commission's Southern San Joaquin Ecosystem Protection Plan (Spiegel and Anderson 1992) has provided the framework on which the resource management agencies have developed their mitigation and conservation strategies.

Several wide-area multispecies (i.e., community level involving thousands of acres) Habitat Conservation Plans are in various stages of development in the San Joaquin Valley as conditions of incidental-take permits under section 10 of the Endangered Species Act of 1973 (P.L. 93-205, 16 U.S.C. 1531 et seq.). Under section 10(a)(1)(B) of the Endangered Species Act, the USFWS can authorize the taking of federally listed fish and wildlife by nonfederal entities if such taking occurs incidentally during otherwise legal activities. An applicant for an incidental take permit submits a Habitat Conservation Plan that specifies, among other things, the impacts that are likely to result from the takings and the measures the permit applicant will undertake to minimize and mitigate such impacts. Many of these Habitat Conservation Plans are an important component of recovery strategies, from protecting specific habitats to restoration to focusing habitat acquisitions to lands identified as important for recovery. The Metropolitan Bakersfield Habitat Conservation Plan has been implemented, and the Kern Valley Floor, and San Joaquin County Habitat Conservation Plans are in active development stages. The other large conservation efforts in the Valley include the Carrizo Natural Heritage Program (USBLM, California Department of Fish and Game [CDFG], The Nature Conservancy), California Energy Commission mitigation programs, the CDFG mitigation program in the Allensworth Natural Area (Spiegel and Anderson 1992), the endangered species habitat protection programs in the Elk Hills (Department of Energy), Occidental of Elk Hills, Kern and Pixley



Derived from the California Gap Analysis Land Cover Map, draft version 1996, produced by the University of California, Santa Barbara Biogeography Lab.

[illegible]

Figure 3. Map showing recent land uses in three categories.

Table 2. *Summary of Larger and Community-level Conservation Efforts in the San Joaquin Valley Planning Area.*

Project [1]	Purpose	Location	Mgmt. Agency [2]	Target Species [3]	Other Species	Approx. Size (acres)	Year Acquired
T & E purchase	nonmitigation	Alkali Sink ER	CDFG	bnll tkr	pbbb hws	945	1978-85
T & E purchase	nonmitigation	Kerman ER	CDFG	bnll tkr sjkf	bso lhsb lso	1,775	1987-88
T & E purchase	nonmitigation	Panoche Hills ER	CDFG	bnll gkr sjkf sjas	tgm	582	1985
T & E purchase	nonmitigation	Buttonwillow	CDFG	bnll sjas sjkf tkr	hws	1,350	1991
T & E purchase	nonmitigation	Allensworth ER	CDFG	bnll sjkf tkr		4,310	1980-85
T & E purchase	nonmitigation	Pixley Conservation Easement	CDFG	bnll tkr		10	1988
T & E purchase	nonmitigation	Semitropic Ridge	CDFG	bnll tkr sjas sjkf	hws sjwt lhsb	588	1982
T & E purchase	nonmitigation	Lokern ER	CDFG	sjkf bnll tkr lcm hws gkr sjas	sjlt antr	327	1988-89
T & E purchase	nonmitigation	Stone Corral ER	CDFG		sjkf	**868	1991-93
Carrizo Plain ER	nonmitigation	Carrizo Plain Natural Area	CDFG	bnll gkr sjas sjkf cjf	sjwt jpg hws antr	8,474	1988-89
Big Sandy WA	nonmitigation	Big Sandy	CDFG		sjkf	**952	1979
Corral Hollow ER	nonmitigation	Corral Hollow	CDFG		sjkf rwr	89	1977
Los Banos WA	nonmitigation	Los Banos WA	CDFG		sjkf	**6,215	1994
Mendota WA	nonmitigation	Mendota WA	CDFG		sjkf tkr bnll pbbb	**11,794	1952-67
North Grasslands WA	nonmitigation	North Grasslands WA	CDFG		sjkf	**6345	1988
Graylodge WA	nonmitigation	Graylodge WA	CDFG		lso	**8,340	1931-74
Elkhorn Plain ER	mitigation	Elkhorn Plain	CDFG	bnll gkr sjkf sjas	hws sjwt tbw	160	1988
Ca Aqueduct	mitigation	Ca Aqueduct/Region 4	CDFG	bnll gkr sjkf tkr	bc hws sjwt	124	1975
Coalinga Gravel Operation	mitigation	Semitropic Ridge	CDFG	bnll sjkf		200	1993
McKittrick Lateral	mitigation	Lokern	CDFG	bnll sjas sjkf		80	1993
Coalinga Cogeneration + Misc.	mitigation	Pleasant Valley	CDFG	bnll sjkf	sjwt sjlt	512	1991
Fiber-Optic Cable	mitigation	Lokern	CDFG	bnll sjas sjkf		287	1990
PGE/PGT Pipeline	mitigation	Jasper Sears Road	CDFG	sjkf		160	1992
Little Panoche Reservoir WA	mitigation	Panoche Hills	CDFG		sjkf bnll antr	**828	1976

TABLE 2. *(continued). Summary of Larger and Community-level Conservation Efforts in the San Joaquin Valley Planning Area.*

Project ¹	Purpose	Location	Mgmt. Agency ²	Target Species ³	Other Species	Approx. Size (acres)	Year Acquired
Misc. mitigations	mitigation	Lokern ER	CDFG	sjkf bnll tkr lom hws gkr sjas	sjlt snkr	140	1992-94
PGE/PGT Pipeline	mitigation	Palm Tract	CDFG	sjkf		1,221	1994
PGE/PGT Pipeline	mitigation	Tracy Hills—Crites/Connelly Ranch	CDFG	sjkf		443	1993
Safeway/Patterson Pass	mitigation	Tracy Hills—Crites/Connelly Ranch	CDFG	sjkf		627	1992
PG&E Stan Pac II & Stockdale Ranch	mitigation	Allensworth ER	CDFG	bnll sjkf tkr	sjas	126	1991
Metropolitan Bakersfield HCP	mitigation	Kern County	CDFG	sjkf bnll gkr sjas tkr		4,093	1992-96
Metropolitan Bakersfield HCP	mitigation	Specialty Preserves	CDFG	bc		317	1993-97
Misc. mitigations	mitigation	Allensworth ER	CDFG	bnll sjkf tkr	sjas	500	1991-95
Los Banos Creek Conservation Easement	mitigation	Los Banos Creek	CDFG	sjkf		85	1993
Salt Creek Conservation Easement	mitigation	Salt Creek	CDFG	sjkf		378	1997
Unimin	on-site mitigation	Unimin Property	CDFG	sjkf		50	1994
Caswell Memorial State Park	nonmitigation	Caswell Memorial State Park	CDPR		rbr rwr	280	1950-96
Ca. Aqueduct Em. Op & Mt. '93	on-site mitigation	SJ Field Division, Chrisman Pumping Plant	DWR	bnll sjkf tkr	bc	212	*
Ca. Aqueduct Em. Op & Mt. '91	mitigation	*	DWR	bnll sjas sjkf tkr		118	*
Ca. Aqueduct Em. Op & Mt. '91	mitigation	*	DWR	sjkf bnll tkr		8.8	*
Coastal Branch Phase II Pipeline	mitigation	*	DWR	bnll gkr sjas sjkf	hws sjlt	1,681	*
CEC Sycamore Cogeneration	mitigation	Semitropic Ridge	CEC	sjkf tkr		1,924	1986-92
CEC Midway/Sunset Cogen.	mitigation	Lokern	CEC	bnll gkr sjkf	snkr	883	1989-92
Misc. mitigations	mitigation	Lokern	CEC	bnll gkr sjkf	snkr	294	1989-91
Caltrans 33/152 Intersection Improvement	mitigation	Jasper Sears Road	Caltrans	sjkf		40	1994-95
Misc. mitigations	mitigation	Semitropic Ridge	CDFG/CEC	sjkf tkr		311	1984-92
Chowchilla Canal Bypass	nonmitigation	Chowchilla Canal Bypass	CDFG/DWR		bnll lss	549	1977
Clifton Court Forebay	nonmitigation	Clifton Court Forebay	CDFG/DWR		sjkf dpcp	**3,000	1972

Table 2. *(continued). Summary of Larger and Community-level Conservation Efforts in the San Joaquin Valley Planning Area.*

Project [1]	Purpose	Location	Mgmt. Agency [2]	Target Species [3]	Other Species	Approx. Size (acres)	Year Acquired
Cottonwood Creek WA	nonmitigation	Cottonwood Creek WA	CDFG/CDPR		sjkf	**6,315	1979
Byron Airport	on-site mitigation	Byron Airport Habitat Management Lands	CDFG/ FAA	sjkf	dpcp	814	1993
Los Vaqueros Reservoir	on-site mitigation	Los Vaqueros Watershed	CDFG/CCWD	sjkf		4,150	1994
San Luis Dam	on-site mitigation	O'Neill Forebay Wildlife Area	CDFG/BOR	sjkf		**700	1976
San Luis Dam	on-site mitigation	San Luis Reservoir Wildlife Area	CDFG/BOR	sjkf		**901	1976
O'Neill Dam Safety Project	on-site mitigation	Interstate 5 corridor	CDFG/BOR	sjkf		171	1994
Springtown Alkali Sink Conservation Easement	mitigation bank	Springtown Alkali Sink	CDFG/Private		pbbt	53	1998
Pixley NWR	nonmitigation	Pixley NWR	USFWS	bnll sjas sjkf	tkr	5,200	1990-94
Antioch Dunes NWR	nonmitigation	Antioch Dunes NWR	USFWS	casb sjdb		60	1980
Sacramento NWR Complex	nonmitigation	Sacramento, Delevan, and Colusa NWR-Uplands	USFWS		pbbb	**5,432	1937-98
Merced NWR	nonmitigation	Merced NWR	USFWS		sjkf bnll	**7034	51
San Luis NWR	nonmitigation	San Luis NWR	USFWS		sjkf	**7500	66
Kern NWR	nonmmitigation	Kern NWR	USFWS		tkr sjkf bvla	**10,618	1960
Bittercreek NWR	nonmitigation	Bittercreek NWR	USFWS	bnll sjkf gkr		**11,400	1985-98
Caltrans widening of 33/166	mitigation	Bittercreek NWR	USFWS	sjkf		40	1999
Tule Vista Farms Conviction	plea agreement	Pixley NWR	USFWS	bnll sjkf tkr		160	1994
Buena Vista Valley Panoche Hills Management Area	nonmitigation	Panoche Hills	USBLM	bnll gkr sjkf	hwa jpg sjwt ankr	5,166	1989-98
Griswold/Tumey Hills Management Area	nonmitigation	Griswold/Tumey Hills	USBLM	gkr sjkf	jpg	8,579	1989-95
Ciervo Hills/Joaquin Rocks Management Area	nonmitigation	Ciervo Hills/Joaquin Rocks	USBLM	bnll gkr sjdb sjkf casb	jpg	21,127	1990-97
Coalinga Management Area	nonmitigation	Coalinga Mineral Springs	USBLM	bnll sjkf	cjf ankr	958	1989-94
Santa Barbara Canyon Allotment	nonmitigation	Santa Barbara Canyon	USBLM	cjf		1779	Public Domain

TABLE 2. *(continued). Summary of Larger and Community-level Conservation Efforts in the San Joaquin Valley Planning Area.*

Project ¹	Purpose	Location	Mgmt. Agency ²	Target Species ³	Other Species	Approx. Size (acres)	Year Acquired
Kreyenhagen Hills Management Area	nonmitigation	Kreyenhagen Hills	USBLM	cjf		1,200	Public Domain
Lokern ACEC	nonmitigation	Lokern	USBLM	sjkf bnll km	sjt snkr	3,110	1988
Kettleman ACEC	nonmitigation	Kettleman Hills	USBLM	sjkf bnll sjas hws sjwt		6,730	1988
Carrizo Plain ACEC	nonmitigation	Carrizo Plain Natural Area	USBLM	bnll gkr sjas sjkf snkr	cjf hws lhab jpg mlt sjwt	103,102	1988-95
Celeron All-American Pipeline	mitigation	Carrizo Plain Natural Area	USBLM	bnll, sjkf, gkr	snkr	140.08 within the 103,102	1989
PG&E UltraPower Ogle Transmission Line	mitigation	Carrizo Plain Natural Area	USBLM	bnll, sjkf	snkr	30 within the 103,102	1990
PSE Sierra, Double C and Kern Front Cogen	mitigation	Carrizo Plain Natural Area	USBLM	sjkf	snkr	137.42 within the 103,102	1991
Valley Waste BV-2	mitigation	Carrizo Plain Natural Area	USBLM	bnll, sjkf, gkr	snkr	88.20 within the 103,102	1991
So Cal Gas North Midway Sunset Pipeline and Buena Vista Pipeline	mitigation	Carrizo Plain Natural Area	USBLM	bnll, gkr, sjkf	snkr	228.34 within the 103,102	1991
Celeron Pentland Pipeline	mitigation	Carrizo Plain Natural Area	USBLM	bnll, sjkf	snkr	21.30 within the 103,102	1991
PG&E UltraPower Ogle Gas Line	mitigation	Carrizo Plain Natural Area	USBLM	sjkf, bnll	snkr	14.86 within the 103,102	1991
Chalk Cliff	mitigation	Carrizo Plain Natural Area	USBLM	sjkf	snkr	20.87 within the 103,102	1991
Mt. Poso Cogen	mitigation	Carrizo Plain Natural Area	USBLM	bnll, sjkf	snkr	40 within the 103,102	1990
Mobil Oil Lease Project	mitigation	Carrizo Plain Natural Area	USBLM	sjkf, bnll, gkr	snkr	1,140 within the 103,102	1992
PSE Inc.	mitigation	Carrizo Plain Natural Area	USBLM	bnll sjkf	snkr	3,048 within the 103,102	1991
Concord Naval Weapons Station	nonmitigation	Concord Naval Weapons Station - Uplands	DOD		sjkf	~6,000	1992

TABLE 2. *(continued). Summary of Larger and Community-level Conservation Efforts in the San Joaquin Valley Planning Area.*

Project ¹	Purpose	Location	Mgmt. Agency ²	Target Species ³	Other Species	Approx. Size (acres)	Year Acquired
Fort Hunter Liggett	on-site mitigation and nonmitigation	on-site management	DOD	sjkf		22,800	1940
Camp Roberts National Guard Training Site	on-site mitigation and nonmitigation	on-site management	DOD/CANG	sjkf		42,784	1940
Lawrence Livermore National Laboratory	on-site mitigation	Site 300	DOE/University of California	dpcp sjkf		**7,000	1953-57
Naval Petroleum Reserve #2	on-site mitigation and nonmitigation	Elk Hills on-site management	DOE	sjkf bnll gkr	sjlt ande	10,280	1980
North Kern Prison	on-site mitigation	on-site management	DOC	bnll sjkf tkr		346	1990
Tracy Hills HCP	on-site mitigation	Tracy Hills	Private/CDFG	sjkf		3,341	88
Romero/Simon Newman	nonmitigation	Romero/Simon Newman Ranches	TNC/USFWS Private	sjkf		**81,000	1988
Numerous Kern Co. Developments	mitigation bank	Coles Levee Ecosystem Preserve	CLEP	bnll gkr sjas sjkf tkr	hws ande	6,059	1992
Carrizo Plain Natural Area	nonmitigation	Carrizo Plain Natural Area	TNC	bnll gkr sjas sjkf	fhab mtl ande	7,428	1987
Sand Ridge	nonmitigation	Sand Ridge	CNLM/TNC	bc	sjwt tkr ande	265	1989-97
Lokern	nonmitigation	Lokern	CNLM	bnll gkr sjas sjkf	hws lcm fhab ande	2,047	1990-94
Laidlaw Pipeline	mitigation	Lokern	CNLM	bnll lcm sjkf		3	1990
Kettleman Hills Waste Facility	mitigation	Semitropic Ridge	CNLM	sjkf		80	1993
Kern Water Bank HCP	nonmitigation	Kern Fan Element	KCWA	sjkf tkr sjas bnll sjwt hws	possible bvls introduction site	19,900	1997
Kern Water Bank Interim Program	mitigation	Kern Fan Element	KCWA	sjkf tkr sjas bnll sjwt hws		488 within the 19,900	1996
Kern Water Bank HCP - Master Permit	mitigation bank	Kern Fan Element	KCWA	sjkf tkr sjas bnll sjwt hws		3,267 within the 19,900	1997
DWR - La Hacienda/Interim Land Management	mitigation	Kern Fan Element	KCWA	sjkf bnll tkr		530 within the 19,900	1997
Kern County Landfill	on-site mitigation	Bena Landfill	Kern County	sjkf		900	1997

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Table 2. (continued). *Summary of Larger and Community-level Conservation Efforts in the San Joaquin Valley Planning Area.*

Project [1]	Purpose	Location	Mgmt. Agency [2]	Target Species [3]	Other Species	Approx. Size (acres)	Year Acquired
Nuevo/Torch HCP	on-site mitigation	Lokern	Nuevo/Torch	sjkf bnll gkr sjas km hws	tgm lhsb	200	1998
East Bay Regional Parks	nonmitigation	Black Diamond Mines	EBRP	sjkf		**5,000	1973-97
East Bay Regional Parks	nonmitigation	Round Valley	EBRP	sjkf		1,984	1988-96
East Bay Regional Parks	proposed mitigation bank	Garaventa Property	EBRP	sjkf		772	1997
East Bay Regional Parks	nonmitigation	Vasco Caves	EBRP/CCWD	sjkf		722	1997
Brushy Peak Preserve	nonmitigation	Brushy Peak	Livermore Area Recreation and Park District		sjkf	**525	1990
Wind Wolves Preserve	nonmitigation	Wind Wolves Preserve—Valley floor	The Wildlands Conservancy	sjkf bnll bc		**34 square miles	1996
Occidental of Elk Hills	on-site mitigation and nonmitigation	Elk Hills on-site management	Occidental	sjkf bnll gkr hws	ons sjlt snkr	38,227	1998
Occidental of Elk Hills	on-site mitigation	Elk Hills	Occidental/USFWS	sjkf bnll gkr hws	ons sjlt snkr	7,075 within the 38,227	*
Springtown Alkali Sink	nonmitigation	Springtown Alkali Sink	City of Livermore		pbbb	300	unknown

* currently under negotiations

** No estimates available for listed species habitat, but significant enough to assist in Recovery efforts.

[1] ER—Ecological Reserve; NWR—National Wildlife Refuge; WA—Wildlife Area
ACEC—Area of Critical Environmental Concern; HCP—Habitat Conservation Plan; T&E—Threatened and Endangered Species

[2] BOR—U.S. Bureau of Reclamation; CANG—California Army National Guard; CCWD—Contra Costa Water District; CDFG—California Department of Fish & Game; CDPR—California Department of Parks and Recreation; CEC—California Energy Commission; CLEP—Coles Levee Ecosystem Preserve; CNLM—Center for Natural Lands Management; DOC—Department of Corrections; DOD—Department of Defense; DOE—Department of Energy; DWR—Department of Water Resources; EBRP—East Bay Regional Parks; FAA—Federal Aviation Administration; KCWA—Kern County Water Agency; TNC—The Nature Conservancy; USBLM—U.S. Bureau of Land Management; USFWS—U.S. Fish & Wildlife Service

[3] bc – Bakersfield cactus; bnll – Blunt-nosed leopard lizard; bss – Bakersfield smallscale; bvls – Buena Vista Lake shrew; casb – Ciervo aegialian scarab beetle; cjf – California jewelflower; cpl – Comanche Point layia; ddw – Doyen's dune weevil; dpcp – Diamond-petaled California poppy; fkr – Fresno kangaroo rat; gkr – Giant kangaroo rat; hws – Hoover's woolly-star; jpg – Jared's peppergrass; km – Kern mallow; lhsb – Lost Hills saltbush; lss – Lesser saltscale; mm – Merced monardella; mp – Merced phacelia; mtt – Munz's tidy-tips; ons – Oil neststraw; pbbb – Palmate-bracted bird's-beak; rbr – Riparian brush rabbit; rwr – Riparian woodrat; sjas – San Joaquin antelope squirrel; sjdb – San Joaquin dune beetle; sjkf – San Joaquin kit fox; sjkr – San Joaquin kangaroo rat; sjlt – San Joaquin Le Conte's thrasher; sjwt – San Joaquin woolly-threads; snkr – Short-nosed kangaroo rat; tbw – Temblor buckwheat; tgm – Tulare grasshopper mouse; tkr – Tipton kangaroo rat; tp – Tejon poppy; vc – Vasek's clarkia

National Wildlife Refuges (Table 2), and the National Wildlife Refuge programs (Kern and San Luis refuge complexes). Several mitigation banks, (i.e., large blocks of land preserved, restored and enhanced for purposes of consolidating mitigation for and mitigating in advance of projects that take listed species) are part of existing or developing Habitat Conservation Plans in the San Joaquin Valley. These include the ARCO Cole's Levee, Kern Water Bank, and Chevron Lokern Habitat Conservation Plans, all in Kern County.

Appropriations from Congress and money provided by the California Wildlife Conservation Board and raised by The Nature Conservancy have resulted in about 83 percent of the 102,640-hectare (253,628-acre) Carrizo Plain Natural Area being in public or The Nature Conservancy ownership. Congressional appropriations and Federal land exchanges were used to acquire 26,102 hectares (64,500 acres) between 1988 and 1995 to add to the 54,442 hectares (134,528 acres) already in Federal ownership. These properties are managed by USBLM. The CDFG has management responsibility for the 2,574 hectares (6,360 acres) the State has purchased, and The Nature Conservancy owns and manages another 2,577 hectares (6,369 acres). The Carrizo Plain Natural Area is a relatively large area, but thousands of acres were farmed for decades and a large proportion is steep, mountainous terrain; less than about 30 percent provided natural habitat for listed species at the time of establishment.

Another large scale program of acquisition, directed by USBLM, is the land purchases and exchange in the western Fresno and eastern San Benito Counties, mainly involving properties known as the Martin or Cantua Creek and Silver Creek ranches (hereinafter called the *Ciervo-Panoche Natural Area*). Acquisitions in these two programs (Carrizo Plain Natural Area and Ciervo-Panoche Natural Area) collectively have done more to advance the recovery of the San Joaquin Valley's listed species than all others combined. Acquisition will continue to be a major element of recovery processes, but will play a lesser role than in the past.

The third large-scale program by the Federal government has been the acquisition of fee title and easements to natural and farmlands in Stanislaus and Merced Counties to add to existing and create new National Wildlife Refuges. Refuge programs have been directed at waterfowl and other wetland species though substantial areas in Merced County are upland communities. With some change in management objectives and habitat restoration, upland areas could support a significantly larger population of kit foxes than currently. Easement lands support a small population of San Joaquin kangaroo rats with a unique genetic constitution, though its subspecies taxonomy is unclear (Johnson and Clifton 1992, Endangered Species Recovery Program unpubl. data). In both counties some riparian areas on existing and planned refuge lands could provide habitat for viable populations of riparian brush rabbits and woodrats.

Additions to the Pixley National Wildlife Refuge, Tulare County, have protected significant habitat for blunt-nosed leopard lizards, Tipton kangaroo rats, San Joaquin kit foxes, and mountain plovers (a candidate species not featured in this plan, but a large proportion of its total population winters in the area covered in this plan). Addition of the Bitter Creek National Wildlife Refuge (foothills and mountains at southwestern edge of the Valley, mostly in Kern County) to the Hopper Mountain refuge complex, though targeted for recovery of the California condor, also provides protection of some habitat for the San Joaquin kit fox, San Joaquin antelope squirrel, Tulare grasshopper mouse, and possibly the blunt-nosed leopard lizard, giant and short-nosed kangaroo rats, mountain plover, and San Joaquin Le Conte's thrasher.

Acquisition of properties in the Allensworth Natural Area of Tulare and Kern Counties and the Semitropic Ridge and Lokern Natural Areas (natural areas defined by Spiegel and Anderson [1992]) by CDFG, California Energy Commission, and Center for Natural Lands Management have been from a variety of funds, both public and private (Table 2). To date, the conservation parcels are relatively small and scattered, but each of the three areas is critical to the recovery of some species. Dedicated conservation lands in each area should expand as the Habitat Conservation Plans are completed and implemented, and if the ongoing planning for a mitigation bank in the Lokern Natural Area by the agencies and Chevron, Inc., is completed and a mitigation bank established.

Several agency management plans and management agreements, which define and commit an agency to managing property in specified ways, exist or are being developed to protect listed species habitat in the San Joaquin Valley. The primary goal of these plans is to ensure that properties with value as habitat for listed species are managed and monitored to preserve, protect, or enhance populations of those species while protecting other societal interests. Plans of this sort represent the principal mechanism for protecting listed species on public lands. Common shortcomings, however, of these plans are lack of adequate information on which to base habitat management actions, and few or no provisions for obtaining needed information. The exceptions are several recently-developed plans that make provisions to conduct research as high priorities (e.g., Center for Natural Lands Management 1993, USBLM et al. 1995).

Critical Needs Analysis.—The status of 32 of the 34 species included in this recovery plan was examined for critical needs as part of the Friant Biological Opinion Critical Needs Analysis (Colliver et al. 1995). Additional species of the Sierra foothills also were included in the analysis, but are not discussed here. The other two species of this recovery plan, the San Joaquin kit fox and the palmate-bracted bird's-beak, were not included, by agreement with the USFWS, because they were dealt with in the critical needs analysis for the contemporaneous Biological Opinion for Interim Contract Renewal (USFWS in litt. 1995*a*). That analysis found that both the San Joaquin kit fox and palmate-bracted bird's-beak had critical needs.

Of the 34 species examined in the two analyses, 12 have critical needs. These species are: palmate-bracted bird's beak, Kern mallow, Bakersfield cactus, Bakersfield smallscale, Vasek's clarkia, oil neststraw, Fresno kangaroo rat, riparian woodrat, Buena Vista Lake shrew, riparian brush rabbit, San Joaquin kit fox, and Doyen's dune weevil. A critical need is defined as any intrinsic state or external situation that threatens a species with extinction or preclusion of recovery and requires action during the next year to improve or avoid a further deterioration of that species' chances of survival and recovery. The critical threats and actions needed for each of the 12 species are reflected in the recovery tasks and priorities established in this recovery plan for these species.

4. Ecosystem-Level Recovery Strategy

Approach to Recovery Planning.—As with many other Federal land-management agencies, the USFWS has adopted an ecosystem approach in managing our Nation's natural resources (USFWS 1994*b*, Henne 1995, USFWS 1995*a*). Given the increasingly severe constraints — environmental, financial, temporal, political, practical, and other — of single-species conservation efforts, consideration of a broader, ecosystem approach to conservation has gained much wider attention in recent years (Salwasser 1991, Costanza et al. 1992, Grumbine 1992, Franklin 1993, Jensen et al. 1993, Scott et al. 1993, Slocombe 1993, Tasse 1993, Wilcove 1993, Alverson et al. 1994, Bormann et al. 1994, Grumbine 1994*a*, 1994*b*, Jensen and Bourgeron 1994, Noss and Cooperrider 1994, Soulé 1994, Alpert 1995, Ecological Society of America 1995*a*, 1995*b*, Kerr 1995, Keystone Center 1991, National Research Council 1995, Noss et al. 1995, Pastor 1995, Tear et al. 1995, Walker 1995, Yaffee et al. 1996).

The ecosystem approach is not, however, without problems and critics (LaRoe 1993, Eisner et al. 1995, Stanley 1995, Wilcove and Blair 1995). Although the ecosystem approach suggests a more simplistic and holistic process for conserving listed species, this approach must still attend to the management and monitoring requirements of key species in the ecosystem to ensure that the ecosystem maintains its integrity — its constituent species and dynamics — and continues to support those species that are most vulnerable to ecosystem change. Though there indeed are many advantages to an ecosystem approach, both the State and Federal endangered species acts still require recovery of individually listed species.

In concert with the evolution of the ecosystem management concept, *adaptive management* has become a somewhat common theme in the conservation literature (Holling 1978, Lee and Lawrence 1986, Walters 1986, Walters and Holling 1990, Boyce 1992 and 1993, Noss and Cooperrider 1994). Adaptive management is the "process of linking management with monitoring within a research framework" (Noss and Cooperrider 1994, p. 298). It is learning by doing, and ongoing monitoring and research are important to learning how to efficiently and sensitively manage ecosystems. Such research will include *population viability analyses* of umbrella species (listed species with the broadest geographic ranges and habitat requirements), keystone species (those which by their numbers or activities have key roles in shaping the species composition or physical structure of the natural community), and indicator species (species whose presence symbolizes certain features of a natural community). Boyce (1992, 1993, p. 525) considers such analyses, if done properly, a natural extension of adaptive management. Population viability analyses require that all available data on a target species be pulled together to

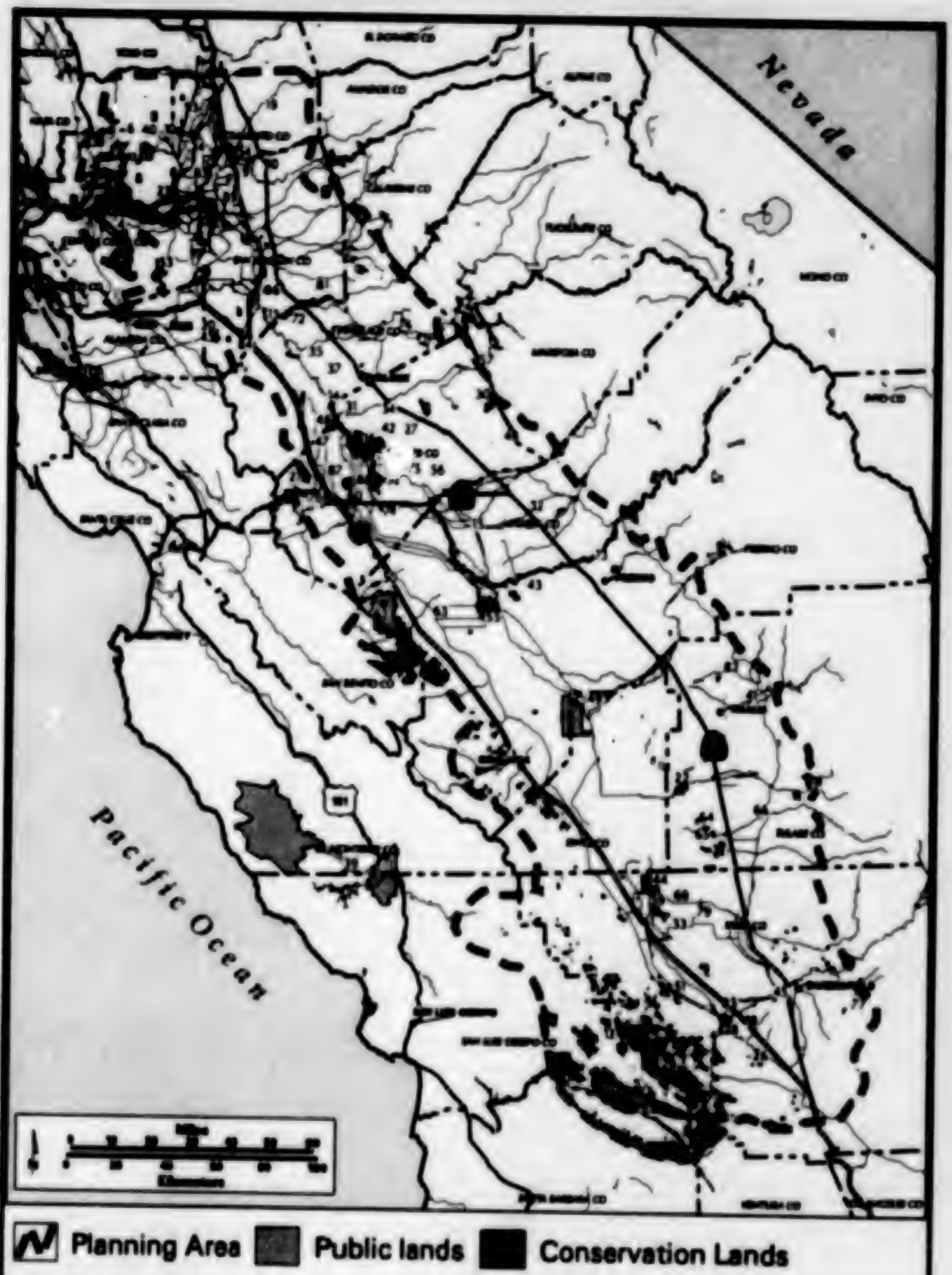

Figure 4. Planning area, showing public and conservation lands.

Table 3. Key to Public and Conservation Land Parcels Shown in Figure 4. ***(Names in italics are those lands which have value to the species covered in this recovery plan. This list is not complete.)***

Name	**Map Number**
Acker Island	1
Alkali Sink Ecological Reserve	2
Allensworth Ecological Reserve	3
Antioch Dunes National Wildlife Refuge	4
Banta-Carbona Fish Screen	5
Barker Slough	6
Bitter Creek National Wildlife Refuge	7
Brannon Island Fishing Access	8
Buttonwillow	9
Calhoun Cut Ecological Reserve	10
Camp Roberts Military Reserve	11
Carrizo Plain Ecological Reserve	12
Carwell Memorial	13
China Island	14
Chowchilla Canal Bypass	15
Claus	16
Clifton Court Forebay Wildlife Area	17
Coles Levee Ecosystem Preserve	18
Cosumnes River	19
Corral Hollow Ecological Reserve	20
Cottonwood Creek (Upper & Lower)	21
Creighton Ranch Preserve	22
Delta Islands	23
Delta Meadows	24
Duck Creek Conservation Easement	25
Duck Pond	26
East Gallo	27
Elk Hills	28
Elkhorn Plains Ecological Reserve	29
Flying M Ranch	30
Freitas	31
Fresno River	32
Goose Lake	33
Grasslands State Park	34
Grayson-San Joaquin River Cone	35
Grizzly Island	36
Hailwood	37
Hill Slough Wildlife Area	38
Hunter Liggett Military Reserve	39
Jepson Prairie	40
Kaweah Oaks Preserve	41
Kelly	42
Kerman Ecological Reserve	43
Kern National Wildlife Refuge	44
Kern River Parkway	45
Kesterson National Wildlife Refuge	46
Kesterson Site	47

TABLE 3. *(continued). Key to Public and Conservation Land Parcels Shown in Figure 4.*

Name	**Map Number**
Le Grand	48
Lemoore Naval Air Station	49
Little Panoche Reservoir Wildlife Area	50
Lokern Preserve	51
Los Banos Wildlife Management Area	52
Los Vaqueros Reservoir Conservation Easement	53
Lost Slough	54
Mendota Wildlife Management Area	55
Merced National Wildlife Refuge	56
Merced River Fish Facility	57
Mount Diablo State Park	58
Northern Semi-Tropic Ridge	59
O'Neill Forebay Wildlife Management Area	60
Paine Preserve	61
Panoche Hills Ecological Reserve	62
Pilibos Mitigation Area	63
Pixley National Wildlife Refuge	64
Pixley National Wildlife Refuge	65
Pixley Vernal Pools Preserve	66
Pleasant Valley	67
Poso Creek Conservation Easement at Semi-Tropic Ridge	68
Rhode Island Delta Riparian Habitat	69
Salt Slough	70
Salt Spring Conservation Easement	71
San Joaquin River National Wildlife Refuge	72
San Joaquin Ecological Reserve	73
San Luis Canal Mitigation Area	74
San Luis National Wildlife Refuge	75
San Luis Reservoir Wildlife Area	76
Sandridge Preserve	77
Schwab	78
Semi-Tropic Ridge	79
Sherman Island Waterfowl Management Area	80
Stanislaus River (Lower)	81
Stone Corral Ecological Reserve	82
Sycamore Island Conservation Easement	83
Tracy Hills	84
Tule Elk State Reserve	85
Vernalis Riparian Habitat Corridor	86
Volta Wildlife Management Area	87
West Gallo	88
White Slough Wildlife Management Area	89
White Slough Wildlife Management Area	90
Woodbridge Ecological Reserve	91
Yaudanchi Ecological Refuge	92
Yolo Basin Conservation Easement	93

build a simulation model, a model that constitutes a synthesis of our current understanding of the target species population. Population viability analyses can then be used to develop hypotheses about how a particular environmental event (e.g., flood, fire) or a new management scenario would affect a target species population. In this way, population viability analyses can guide the direction of management. This approach could help direct the recovery of some key species in the San Joaquin Valley.

The planning area addressed in this recovery plan (Figure 4; key to numbered locations is in Table 3)—the San Joaquin Valley, Carrizo and Elkhorn Plains, and parts of the Cuyama, Salinas, Sacramento, and other valleys—is a "focus area" in the USFWS Central Valley of California/San Francisco Bay and South Pacific Coast ecosystem units (USFWS 1995a). However, this focus area differs in a number of significant ways from lands addressed in other ecosystem-level conservation efforts. Those efforts generally involve millions of acres of publicly-owned lands, often with large expanses of wilderness (e.g., Clark and Zaunbrecher 1987, Everett et al. 1994).

Of the 45,500 square kilometers (17,500 square miles) in the planning area, exclusive of the Salinas and Pajaro watersheds, only about 2,600 square kilometers (1,000 square miles) are in public and conservation ownership, about 5.7 percent. This contrasts dramatically with other ecosystem efforts throughout the west and with land ownership in other parts of California. The San Joaquin Valley has much more land in private ownership than any of California's nine other bioregions. Most of the landscape, 95 percent or more, has been altered from its natural state and replaced by irrigated agriculture, cities and towns, and industrial developments. Within this human-shaped mosaic are sparsely scattered remnants of natural communities, all of which have been severely degraded, altered, and fragmented by human activities. One of the most basic and prominent of ecosystem features on the San Joaquin Valley floor—seasonal flooding by winter storms and snowmelt in the towering Sierra Nevada—has been nearly eliminated by the dams, reservoirs, pumps, diversion channels, and canals that capture its waters for use by agriculture and municipalities, some outside its boundaries. All the natural communities shaped and maintained by seasonal runoff no longer function normally, which has led to their endangerment.

This recovery plan acknowledges that if recovery is to be achieved, it must take place within the constraints of the existing human-dominated ecosystem. Trust, partnership, and common purpose must be established amongst government agencies, ranchers, farmers, developers, conservationists, urbanites, and other citizens of the Valley.

If implemented, the outcome of this planning effort most probably will retain the advantages of ecosystem-level conservation: involving all segments of society in recovery actions; preserving all or most species simultaneously; saving effort and money; and increasing the chances that recovery efforts will succeed.

II. SPECIES ACCOUNTS

A. California Jewelflower
(*Caulanthus californicus*)

1. Description and Taxonomy

Taxonomy.—The appropriate genus for California jewelflower has been debated (Payson 1923, Rollins 1971, Al-Shehbaz 1973), but it has been recognized consistently as a distinct species. Watson (1880) originally named the genus *Stanfordia* solely to accommodate this species. The *type specimen* (i.e., the individual plant on which the original description was based) of *Stanfordia californica* was collected "near Tulare" in Tulare County. Greene then transferred the species to *Streptanthus* in 1891 (Greene 1891 as cited in Taylor and Davilla 1986). The currently accepted scientific name for California jewelflower, *Caulanthus californicus*, was published by Payson (1923). California jewelflower is a member of the mustard family (Brassicaceae).

Description.—California jewelflower has hairless, usually branching stems, which can range from less than 10 centimeters (4 inches) to more than 50 centimeters (20 inches) tall (Munz and Keck 1959, Mazer and Hendrickson 1993*a*, Cypher 1994*a*). The upper leaves are egg-shaped and clasp the stem, unlike the leaves at the base of the plant, which are oblong. The maroon buds are clustered at the tip of the stem and contrast with the translucent, white flowers below. The fruits of California jewelflower are 1 to 6 centimeters (0.4 to 2.4 inches) long, and flattened (Buck 1993).

Identification.—California jewelflower (Figure 5) differs from all other species of *Caulanthus* in that it has flattened, sword-shaped fruits and spherical seeds. Other jewelflowers also have maroon buds and whitish flowers, but those that overlap in range with California jewelflower have narrow, elongated fruits and flattened seeds (Buck 1993).

2. Historical and Current Distribution

Historical Distribution.—The historical distribution of California jewelflower is known from 40 herbarium specimens, which were collected in 7 counties between 1880 and 1973. Approximately half of the collection sites were on the floor of the San Joaquin Valley in Fresno, Kern, and Tulare Counties (Figure 6). Several other collections came from two smaller valleys southwest of the San Joaquin Valley: the Carrizo Plain (San Luis Obispo County) and the Cuyama Valley (Santa Barbara and Ventura Counties). Three *occurrences* (i.e., collection sites separated by 0.4 kilometer [0.25 mile] or more) were in the Sierra Nevada foothills at the eastern margin of the San Joaquin Valley in Kern County. The remainder of the historical sites were in foothills west of the San Joaquin Valley, in Fresno, Kern, and Kings Counties (CDFG 1995, Taylor and Davilla 1986).

Current Distribution.—By 1986, all the occurrences on the San Joaquin and Cuyama Valley floors had been eliminated, and the only natural population known to be *extant* (i.e., still in existence) was in Santa Barbara Canyon, which is adjacent to the Cuyama Valley in Santa Barbara County (Taylor and Davilla 1986). A small, introduced colony also existed at the Paine Preserve in Kern County at that time. Since then, several more introductions have been attempted (see *Conservation Efforts*), and a number of colonies were rediscovered in two other areas where the species had been collected historically. The naturally-occurring populations of California jewelflower that are known to be extant today are in three centers of concentration: (1) Santa Barbara Canyon, (2) the Carrizo Plain in San Luis Obispo County, and (3) the Kreyenhagen Hills in Fresno County (CDFG 1995, Danielsen et al. 1994, B. Delgado pers. comm., R. Lewis pers. comm.).

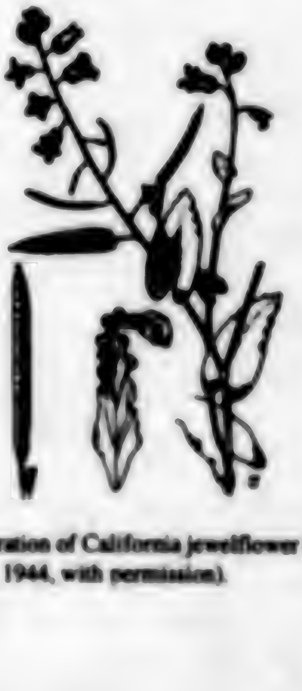

Figure 5. Illustration of California jewelflower (from Abrams, Vol. 2, 1944, with permission).

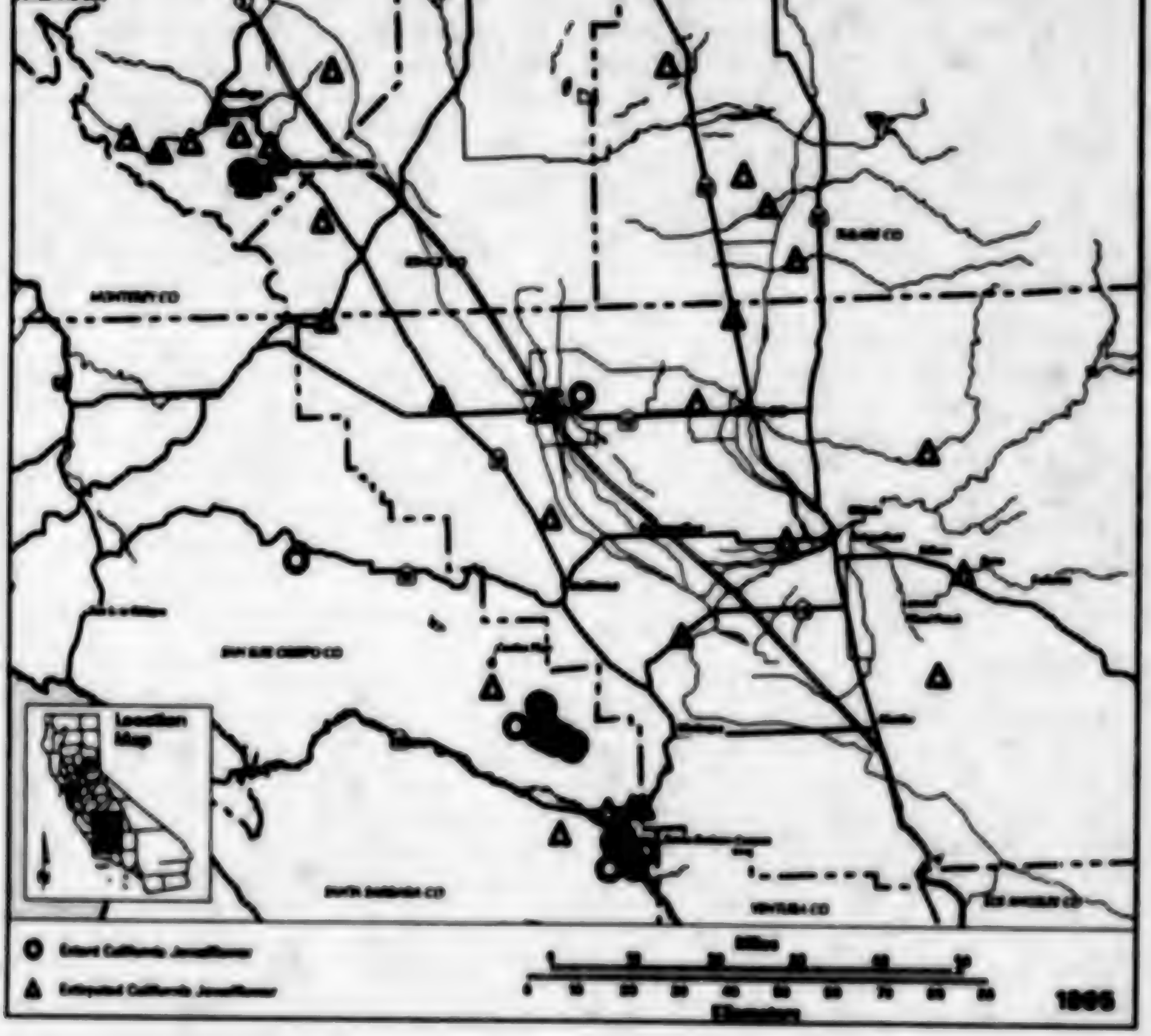

Figure 6. Distribution of California jewelflower (*Caulanthus californicus*).

The Santa Barbara Canyon *metapopulation* (i.e., scattered groups of plants that may function as a single population due to occasional interbreeding) occurs in an area of approximately 10 by 1 kilometer (6.5 by 0.5 mile) on the terraces just west of the Cuyama River and includes approximately 12 hectares (30 acres) of occupied habitat. The Carrizo Plain metapopulation is confined to the western side of the Carrizo Plain in a roughly triangular area measuring approximately 15 by 13 by 10 kilometers (9 by 8 by 6 miles) and encompassing approximately 4 hectares (10 acres) of occupied habitat (R. Lewis pers. comm.). The Kreyenhagen Hills metapopulation includes 4 small colonies within a 3 by 1 kilometer (2 by 0.5 mile) area of rolling hills (USBLM in litt. 1994).

Additional populations of California jewelflower may persist in the foothills of Fresno, Kern, and Kings Counties, where potential habitat remains in rangeland. However, access to historical sites in these areas has been restricted, so the presence of the species has not been verified in over 50 years (CDFG 1995, Taylor and Davilla 1986).

3. Life History and Habitat

California jewelflower is an annual, meaning that each plant lives less than 1 year, and the entire life cycle from seed germination to seed set is completed in a single growing season. As is typical of annuals, both plant size and population size in California jewelflower can vary dramatically, depending on site and weather conditions (Taylor and Davilla 1986, Mazer and Hendrickson 1993*a*, Cypher 1994*a*).

Reproduction and Demography.—Seeds of California jewelflower begin to germinate in the fall when the rainy season begins, but additional seedlings may continue to emerge for several months. California jewelflower seedlings develop into rosettes (clusters of leaves at ground level) during the winter months, and the stem elongates as flower buds begin to appear in February or March. Flowering and seed set continue until the plants die, which may occur as late as May in years of favorable rainfall and temperatures. Seed-dispersal agents are not known, but those that have been suggested for California jewelflower and related genera include gravity, seed-eating animals (Cypher 1994*a*), wind, and water (Al-Shehbaz 1973).

California jewelflower probably forms a persistent seed bank. In greenhouse trials, viable seeds did not germinate even when exposed to a variety of typical temperature and moisture conditions (Taylor and Davilla 1986). Only conditions simulating prolonged weathering induced seed germination (Mazer and Hendrickson 1993*a*). A persistent seed bank ensures that some seeds will be available to produce plants in succeeding years, even if no individuals survive to set seed in one unfavorable growing season (Philippi 1993). The presence of a seed bank would explain the reappearance of California jewelflower in uncultivated areas where it had not been observed for decades.

Pollinator-exclusion experiments indicated that insects are necessary for seed set in California jewelflower (Mazer and Hendrickson 1993*a*). Honeybees (*Apis mellifera*) have been observed visiting the flowers (R. Lewis pers. comm.), but native insects also would be expected to serve as pollinators. Solitary bees of the genus *Synhalonia* are known to visit Coulter's jewelflower *(Caulanthus couteri)* (Thorp in litt. 1998). Closely-related species of the genus *Thelypodium* were visited by several species of bees (*Bombus* sp., *Apis* sp., and *Xylocopa* sp.) and butterflies (*Pieris* sp.) (Al-Shehbaz 1973). Both cross- and self-pollination resulted in seed set in greenhouse trials (Mazer and Hendrickson 1993*a*).

In 1992 and 1993, which were years of above-average rainfall during the growing season, 46 percent to 85 percent of plants in study areas on the Carrizo Plain survived long enough to produce seed (Mazer and Hendrickson 1993*a*, Cypher 1994*a*). However, in years of below-average precipitation or above-average temperatures, all the plants may die before setting seed (R. van de Hoek pers. comm.). Seed production in California jewelflower may vary greatly among individuals, sites, and years. In 1992, average seed production per plant was 711 on the Carrizo Plain and 278 in Santa Barbara Canyon (Mazer and Hendrickson 1993*a*). In 1993, the estimated number of seeds per plant on the Carrizo Plain ranged from 4 to over 11,000 and averaged 929, compared to 49 in the Kreyenhagen Hills (E. Cypher unpubl. data).

Habitat and Community Associations.—Extant populations of California jewelflower occur in Nonnative Grassland, Upper Sonoran Subshrub Scrub, and Cismontane Juniper Woodland and Scrub (E. Cypher unpubl. data). Historical records suggest that California jewelflower also occurred in the Valley Saltbush Scrub community in the past (CDFG 1995).

Herbaceous cover was dense at most California jewelflower sites studied in 1993 (Cypher 1994*a*). Native plant species, such as annual fescue (*Vulpia microstachys*), clovers (*Trifolium* spp.), red maids (*Calandrinia ciliata*), and goldfields (*Lasthenia californica*) comprised a high proportion of the vegetation at many of the known locations over several years. The exotic grass red brome (*Bromus madritensis* ssp. *rubens*) was a significant component of the vegetation only at the Carrizo Plain sites (Taylor and Davilla 1986, Lewis in litt. 1993, Cypher 1994*a*, E. Cypher unpubl. data). On the Carrizo Plain, California jewelflower occurred primarily on the burrow systems of giant kangaroo rats (*Dipodomys ingens*), another endangered species (Cypher 1994*a*).

Populations of California jewelflower have been reported from elevations of approximately 75 to 900 meters (240 to 2,950 feet) and from level terrain to 25 percent slopes. Soils at known sites are primarily subalkaline, sandy loams (CDFG 1995, Taylor and Davilla 1986, Lewis in litt. 1993).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—The primary reason for the decline of California jewelflower was habitat destruction. All the populations on the San Joaquin and Cuyama Valley floors have been eliminated. Conversion to agriculture accounted for the loss of most sites, but those closest to Bakersfield and Fresno were destroyed by urbanization. Oilfield activity may have eliminated a few sites in the foothills at the western margin of the San Joaquin Valley (Taylor and Davilla 1986).

Threats to Survival.—Development remains a threat in Santa Barbara Canyon, where more than 90 percent of the California jewelflower metapopulation occurs on private land. The California jewelflower habitat near the canyon mouth is for sale; the landowner cleared California junipers (*Juniperus californica*) from the site and planted ornamentals in anticipation of residential development (Lewis in litt. 1993). California jewelflower on private land in the upper portion of Santa Barbara Canyon is subject to cattle grazing throughout the growing season, but the magnitude of threat posed by livestock is unknown. Grazing in the period between the rosette stage and seed set is believed to be detrimental to California jewelflower because seed set would be reduced if flowering or fruiting stems were consumed (Mazer and Hendrickson 1993*a*, R. Lewis pers. comm.).

Potential threats to one or more of the remaining populations of California jewelflower include competition from exotic plants, the effects of certain insecticides on pollinators, and small population size. In a preliminary study, seedling mortality was higher in plots that contained dense vegetation than in plots where all plants but California jewelflower had been removed (Mazer and Hendrickson 1993*a*). Red brome could be particularly competitive because some strains are resistant to air pollution (Westmann et al. 1985 in Taylor and Davilla 1986). Insecticides could present a threat to California jewelflower viability on the Carrizo Plain by decreasing pollinator populations. Prior to 1980, the California Department of Food and Agriculture sprayed malathion on the Carrizo Plain to control beet leafhoppers. The effect of malathion on native insect populations has not been investigated. Thus, it is unknown whether fall spraying would affect pollinator populations the following spring, or how large a buffer zone would be needed to avoid affecting insects that pollinate California jewelflower. Under the current environmental assessment and pesticide use permit, spraying has been suspended on the Carrizo Plain, at least through the year 2001 (California Department of Food and Agriculture in litt. 1998). Small population size may be another factor in the continued existence of California jewelflower.

5. Conservation Efforts

California jewelflower was state listed as endangered in 1987 and federally listed as endangered in 1990 (USFWS 1990; Table 1). Intensive and extensive survey efforts were undertaken by biologists from the California Energy Commission, USBLM, and U.S. Forest Service, beginning in 1987. Their efforts led to the discovery of many new occurrences and the rediscovery of several that were thought to have been eliminated. Surveys for additional populations are continuing in suitable habitats on the Los Padres National Forest and USBLM lands in the Bakersfield District (Danielsen et al. 1994, B. Delgado pers. comm., R. Lewis pers. comm.).

The known California jewelflower habitat in two of the three concentration areas is in public ownership. The Carrizo Plain metapopulation is entirely within the Carrizo Plain Natural Area, which is administered jointly by USBLM, The Nature Conservancy, and CDFG. USBLM also administers the Kreyenhagen Hills and a small part of Santa Barbara Canyon. Populations in each of these areas have been monitored annually by USBLM personnel since 1991. USBLM no longer allows green-season grazing in California jewelflower habitats under its management, which include approximately 40 percent of individuals known to be extant. In 1994, an exclosure was constructed around the plants on public land in Santa Barbara Canyon to preclude grazing (R. Lewis pers. comm.).

Several experimental introductions of California jewelflower have been attempted in Kern, Santa Barbara, and Tulare Counties on lands protected by The Nature Conservancy and the Los Padres National Forest (Taylor 1988, CDFG 1995). In all instances, the number of plants at each site has declined precipitously following the initial seeding (Taylor and Davilla in litt. 1986, Danielsen et al. in litt. 1994). Possible causes of failure included unfavorable site conditions, use of seed sources that were not adapted to the introduction site, lack of genetic diversity in the introduced populations, and insufficient numbers of seeds (Taylor and Davilla 1986, Mazer and Hendrickson 1993*a*, Danielsen et al. 1994). Considering the variable germination rates in natural populations, plants may reappear at some of the reintroduction sites after several years. Future reintroduction efforts can build on the experience gained from these early trials.

Preliminary research on the reproductive biology, demography, and ecology of California jewelflower has been conducted by Dr. Susan Mazer and associates from the University of California, Santa Barbara, and by Dr. Ellen Cypher and associates from the Endangered Species Recovery Program. Funding for these studies was provided by CDFG, the National Science Foundation, USBLM, and Endangered Species Recovery Program. The U.S. Natural Resources Conservation Service is considering artificial propagation of California jewelflower to aid research and restoration efforts (D. Dyer pers. comm.).

6. Recovery Strategy

Although restoration of California jewelflower to all its former sites of occurrence is not feasible, the recovery goal is to maintain self-sustaining populations in protected areas representative of the former geographic and topographic range of the species and in a variety of appropriate natural communities. Surveys will be necessary to determine whether natural populations remain in all target areas. Where natural populations no longer exist, such as the floor of the San Joaquin Valley, reintroduction will be necessary to achieve recovery. However, reintroduction is expensive and experimental, and thus the preferable course of action is to locate and protect the remaining occupied habitat wherever possible. Unoccupied habitat within *metapopulations* also should be protected to facilitate movement of pollinators and seed dispersers. Thus, additional elements of the strategy are to protect land in blocks of at least 65 hectares (160 acres) and to avoid fragmenting any metapopulation into more than two blocks of contiguous, protected natural land. Finally, buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion.

The top-priority action for recovery of California jewelflower is to protect the plants on private land in Santa Barbara Canyon. The site could be secured through fee title acquisition or conservation easements. Continued protection and appropriate management of all occupied habitat on public lands also is important. A number of additional tasks are required to achieve recovery goals. These tasks include developing management plans, surveying for additional populations, banking seed, conducting research, and modeling population demographics using *matrix projection modeling*. Interim management plans should be developed for each protected area to ensure that recovery of California jewelflower and other listed species is the primary goal. Management plans may need to be revised if populations begin declining or research identifies limitations to population viability.

Surveys are particularly important in the foothills east of the San Joaquin Valley to determine if historical populations remain extant. If populations are rediscovered in that area their protection would be a high-priority task because they are likely to incorporate genotypes not found elsewhere in the range. Seeds should be collected from each of the known metapopulations and any occurrences discovered in the future, according to the guidelines established by the Center for Plant Conservation (1991). Seed collections should be used for two purposes: to conserve the genetic diversity of the species in seed-banking facilities; and to allow greenhouse propagation of the species, which would allow experimental introductions and manipulative studies without jeopardizing natural populations or continuing to deplete natural seed banks (Mazer and Hendrickson 1993*a*). Continued demographic research is necessary to determine which stages in the life cycle are limiting (Schemske et al. 1994). Limiting factors may vary among California jewelflower populations and can include pollinator availability, competition from introduced plants, consumption by kangaroo rats or livestock, or physical site characteristics (Mazer and Hendrickson 1993*a*, Cypher 1994*a*). Annual monitoring also is necessary to indicate whether population levels are increasing, decreasing, or remaining stable (Cypher 1994*a*, Schemske et al. 1994).

B. PALMATE-BRACTED BIRD'S-BEAK
(CORDYLANTHUS PALMATUS)

1. Description and Taxonomy

Taxonomy.—Palmate-bracted bird's-beak, a member of the snapdragon family (Scrophulariaceae), was first described as *Adenostegia palmata* (Ferris 1918). The *type locality* (i.e., the site from which the type specimen was collected) was "at Tule near College City, Colusa County" (Ferris 1918, p. 420). In a subsequent revision, *Adenostegia* was transferred to the genus *Cordylanthus* (Macbride 1919), resulting in the currently-accepted name *Cordylanthus palmatus* (Chuang and Heckard 1993). Plants from the southern portion of the range initially were considered by Pennell (1947) to be a different species, fleshy bird's-beak (*Cordylanthus carnulosus*). The type specimen of fleshy bird's-beak was collected 6 miles south of Kerman, in Fresno County (Chuang and Heckard 1973). *Cordylanthus carnulosus* later was reduced to a subspecies of *C. palmatus* (Munz 1958), and finally was merged completely with *C. palmatus* (Chuang and Heckard 1973).

Description.—Palmate-bracted bird's-beak (Figure 7) is a highly branched annual that can reach 30 centimeters (12 inches) in height. The glandular hairs are short (less than 1 millimeter; less than 0.04 inch) and excrete salt crystals, making mature plants appear grayish-green. In all *Cordylanthus* species, the *corolla* (the set of petals) is club-shaped and is divided lengthwise into two *lips* (groups of fused petals that differ in appearance). The upper lip is hooked like a bird's beak and the lower lip is inflated like a pouch. The flowers are nearly hidden by *bracts*, which are leaf-like structures. In palmate-bracted bird's-beak, the outer bracts are green; the inner bracts are lavender and deeply divided into finger-like segments (i.e., *palmate*). The corolla is hairy, whitish to lavender on the sides, and has fine purple stripes on the lower lip. The seeds have distinctive arching crests.

Identification.—Palmate-bracted bird's-beak differs from the closely-related hispid bird's-beak (*C. mollis* ssp. *hispidus*) in that the latter has bristly hairs longer than 1 millimeter (0.04 inch), whitish to yellowish flowers, and lacks crests on the seeds (Ferris 1918, Chuang and Heckard 1993). Fleshy bird's-beak is distinguished from palmate-bracted bird's-beak by its branching pattern and hair characteristics (Chuang and Heckard 1973).

2. Historical and Current Distribution

Historical Distribution.—Nine natural populations of palmate-bracted bird's-beak were documented between 1916 and 1982, but only two were known to be extant as of 1985 (USFWS 1986). The historical occurrences were in the following vicinities: College City; Livermore (Alameda County); Alkali Sink Ecological Reserve, Kerman, and two near Mendota (Fresno County); between Firebaugh and Madera (Madera County); Stockton (San Joaquin County); and Woodland (Yolo County) (Chuang and Heckard 1973, CDFG 1995, Heckard 1977). Hoover (1937) indicated that palmate-bracted bird's-beak grew near Bakersfield, but that locality has not been substantiated.

Current Distribution.—As a result of intensive survey efforts and additional introductions, palmate-bracted bird's-beak now is known to occur in seven metapopulations: four in the Sacramento Valley, one in

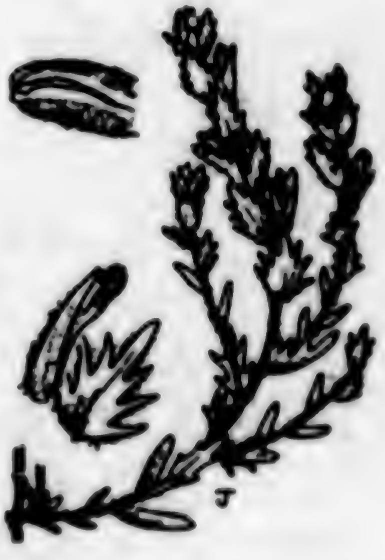

Figure 7. Illustration of palmate-bracted bird's-beak (from Abrams, Vol. 3, 1951, with permission).

the Livermore Valley, and two in the San Joaquin Valley (Figure 8). In approximate order from north to south, these metapopulations are (1) Sacramento National Wildlife Refuge in Glenn County, (2) Delevan National Wildlife Refuge in Colusa County, (3) Colusa National Wildlife Refuge in Colusa County, (4) the Woodland area, (5) Springtown Alkali Sink near Livermore, (6) western Madera County, and (7) the combined Alkali Sink Ecological Reserve and Mendota Wildlife Management Area. The total occupied surface area over the seven metapopulations is estimated at less than 300 hectares (741 acres). The Delevan National Wildlife Refuge and Colusa National Wildlife Refuge metapopulations account for approximately 80 percent of the total number of individuals, and the Springtown Alkali Sink metapopulation accounts for another 19 percent (Center for Conservation Biology 1994, CDFG 1995).

3. Life History and Habitat

Cordylanthus species are *hemiparasitic* annuals, meaning that they manufacture their own food but obtain water and nutrients from the roots of other plants (i.e., *host plants*; Chuang and Heckard 1971). Saltgrass (*Distichlis spicata*) is the most likely host plant for palmate-bracted bird's-beak. The combination of hemiparasitism, salt excretion, and a deep root system allows palmate-bracted bird's-beak to grow during the hot, dry months after most other annuals have died (Coats et al. 1993).

Reproduction and Demography.—This species flowers from May until October (Skinner and Pavlik 1994). Bumblebees (*Bombus californicus*, *B. occidentalis*, and *B. vosnesenskii*) were the primary pollinators of palmate-bracted bird's-beak at the Springtown Alkali Sink in 1993. The bees nested in uplands more than 100 meters (328 feet) distant from the population, and each bee visited only one group of palmate-bracted bird's-beak plants (Center for Conservation Biology 1994). Both self- and cross-pollination can contribute to seed-set (Center for Conservation Biology 1993), and individual plants can produce up to 1,000 seeds in a single growing season (Center for Conservation Biology 1991). Despite the formation of a persistent seedbank, the number of plants in a population varies yearly in response to environmental conditions, particularly precipitation (Center for Conservation Biology 1994). Seasonal overland flooding may disperse seeds and promote seed germination by diluting the saline soils (Coats et al. 1993); in laboratory tests, seed germination rates were significantly higher in low-salinity than in high-salinity solutions, regardless of alkalinity (Center for Conservation Biology 1991). However, prolonged flooding would not be conducive to survival of palmate-bracted bird's-beak (A. Howald pers. comm.).

Genetic studies of the Colusa, Delevan, Springtown, and Alkali Sink Ecological Reserve/Mendota National Wildlife Refuge populations indicated that the Springtown metapopulation incorporated almost all the genetic variability known in the species. The Alkali Sink Ecological Reserve population contributed some additional genetic variation, but the Colusa and Delevan National Wildlife Refuge metapopulations did not. Thus, protection of the Springtown and Alkali Sink Ecological Reserve metapopulations was considered to be crucial to recovery (Center for Conservation Biology 1994). Samples from Sacramento National Wildlife Refuge, Woodland, and Madera County were not evaluated.

Habitat and Community Associations.—This species is restricted to seasonally-flooded, saline-alkali soils in lowland plains and basins at elevations of less than 155 meters (500 feet). Within these areas, palmate-bracted bird's-beak grows primarily along the edges of channels and drainages, with a few individuals scattered in seasonally-wet depressions, *alkali scalds* (barren areas with a surface crust of salts), and grassy areas. Palmate-bracted bird's-beak occurs in the Valley Sink Scrub and Alkali Meadow natural communities in association with other halophytes such as iodine bush (*Allenrolfea occidentalis*), alkali heath (*Frankenia salina*), glasswort (*Salicornia subterminalis*), seepweed (*Suaeda moquinii*), and salt grass (Holland 1986, Coats et al. 1993, CDFG 1995, Bittman 1985, 1986*a*). At Springtown Alkali Sink, palmate-bracted bird's-beak and hispid bird's-beak occur together (Center for Conservation Biology 1994). Suitability of microhabitats for palmate-bracted bird's-beak depends primarily on soil pH and to a lesser extent on soil layering, salinity, and moisture. This species occurs on neutral to alkaline soils (pH 7.2 to 9.5) under natural conditions but has been grown on acidic soils in greenhouse trials (Coats et al. 1993, Center for Conservation Biology 1993, 1994).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—Agricultural conversion eliminated the formerly-known palmate-bracted bird's-

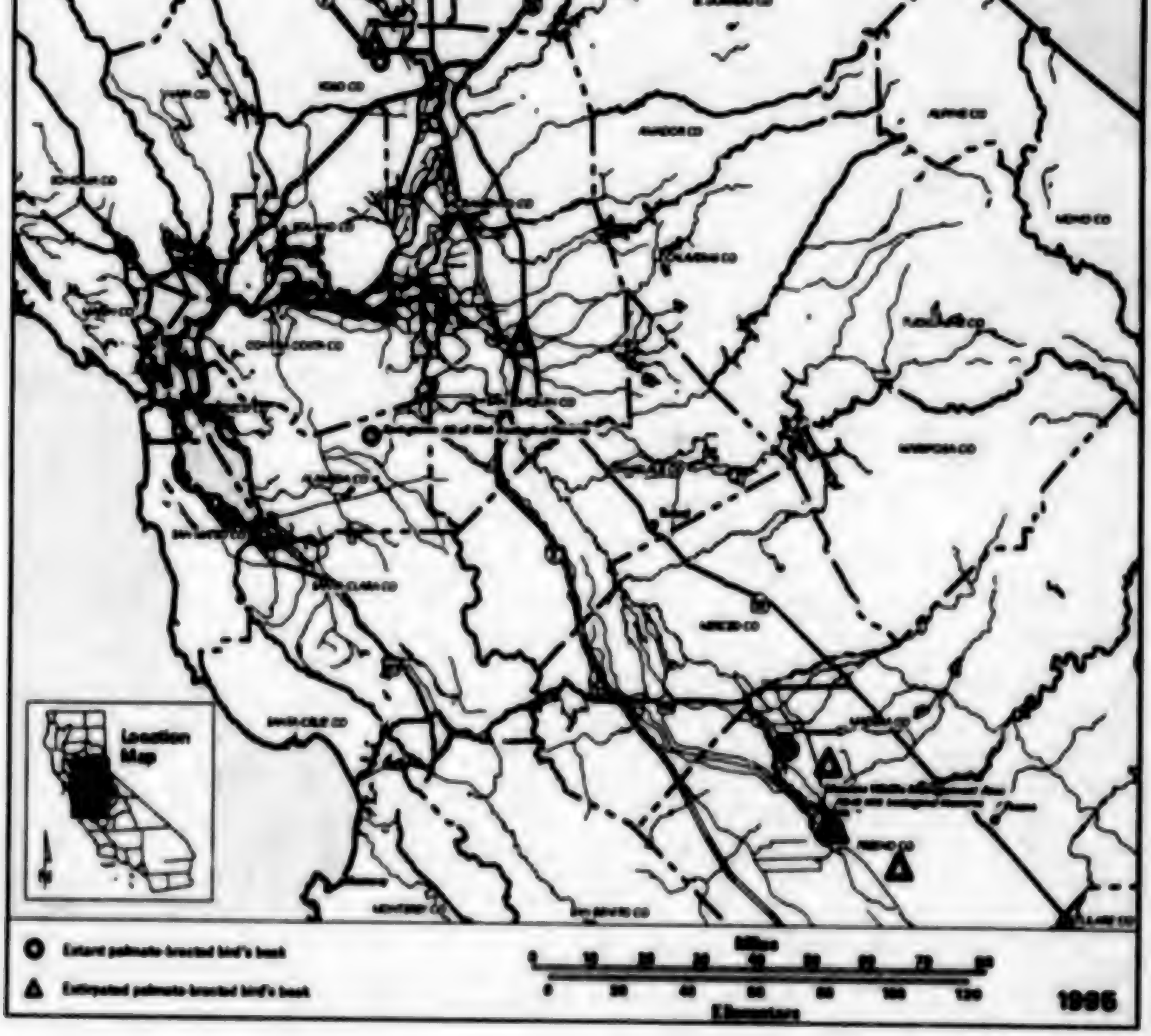

Figure 8. Distribution of palmate-bracted bird's-beak *(Cordylanthus palmatus)*.

beak populations near College City, Kerman, and southeast of Mendota; reduced the size of the Woodland population; and destroyed extensive areas of potential habitat in the Sacramento and San Joaquin Valleys. Urban development was responsible for the destruction of the Stockton occurrence.

Threats to Survival.—Urban expansion (including commercial uses, residential development, and construction of recreational facilities) poses imminent threats at the Springtown and Woodland sites. Numerous other factors threaten the remaining populations. Changes in the *hydrologic regime* (seasonal water cycles and movements) by drainage, diking, and channelization have interrupted the seasonal overland flows and altered water salinity at Springtown, Woodland, and on lands adjacent to the Alkali Sink Ecological Reserve and National Wildlife Refuges. Because of the lack of genetic variability within and among the Sacramento Valley populations and the limited number of individuals in the Alkali Sink Ecological Reserve, western Madera County, and Woodland populations, random or catastrophic events could result in elimination of the species at any of these sites. Road maintenance is a potential threat at the Alkali Sink Ecological Reserve. The Springtown metapopulation faces many additional threats, including unauthorized fill of wetlands, encroachment by exotic plant species, off-road vehicle use, and livestock wallowing in seasonal pools (Coats et al. 1993, Center for Conservation Biology 1994, CDFG 1995, A. Howald pers. comm.).

5. Conservation Efforts

The state of California listed palmate-bracted bird's-beak as an endangered species in 1984, and USFWS did likewise in 1986 (USFWS 1986). In 1988, CDFG funded a project to map suitable habitats from aerial photographs and soil survey data (A. Howald pers. comm.). Since then, CDFG has sponsored intensive research on the biology, ecology, and management of palmate-bracted bird's-beak at the Springtown Alkali Sink. The first study focused on habitat characterization and resulted in development of a management plan for the area (Coats et al. 1993). The next series of investigations into the life history, reproductive biology, genetic composition, and site relationships were conducted by the Center for Conservation Biology and resulted in development of a long-term monitoring program for the Springtown Alkali Sink (Center for Conservation Biology 1994). Part of the Springtown Alkali Sink has been proposed as a mitigation banking area for surrounding development; under the proposed plan, restoration and management also would be undertaken (Coats et al. 1993). However, the mitigation bank would protect at most 25 percent of occupied habitat; it is a commercial enterprise that will continue only as long as it is profitable, and restoration may not begin for many years (A. Howald pers. comm.). A hydrologic study of the North Livermore Valley watershed is currently underway. Preliminary recommendations are contained in a report by Questa Engineering Corporation (1997), and include measures to reduce urban runoff and protect groundwater flows from the saline foothills north and northeast of the sink.

Personnel at the Sacramento National Wildlife Refuge complex have contributed to conservation of palmate-bracted bird's-beak in several ways. In 1990, National Wildlife Refuge biologists established a new population at Sacramento National Wildlife Refuge by scattering seeds that had been collected from Delevan National Wildlife Refuge. The National Wildlife Refuge complex avoids inundating known occurrences of palmate-bracted bird's-beak, and the hydrology and vegetation in occupied habitat are being restored to historical conditions. Refuge staff also monitor known populations on the Sacramento National Wildlife Refuge complex annually and consider the species when any management activities are proposed or planned in occupied habitat (G. Mensik pers. comm.). At least one group of plants has been fenced to restrict vehicle access and reduce the potential for trampling by waterfowl hunters (M.A. Showers pers. observ.).

Additional conservation efforts have included surveys and another reintroduction. The palmate-bracted bird's-beak population on private land in western Madera County was discovered in 1993 during surveys by the Endangered Species Recovery Program. A small transplant colony was established at the Mendota Wildlife Management Area in 1973 using seed collected from a nearby population that was about to be eliminated (CDFG 1995, Heckard 1977). The Endangered Species Recovery Program currently is conducting demographic studies of palmate-bracted bird's-beak at Alkali Sink Ecological Reserve. Seeds will be collected from this population in fall 1998 for banking at a Center for Plant Conservation facility.

6. Recovery Strategy

The recovery goal for palmate-bracted bird's-beak is to maintain self-sustaining populations in protected areas representative of the former geographic and topographic range of the species and in a variety of appropriate natural communities. Surveys will be necessary to determine whether natural populations remain in all target areas; if natural populations are not found, reintroduction will be necessary to achieve recovery. However, reintroduction is expensive and experimental, and thus the preferable course of action is to locate and protect the remaining occupied habitat wherever possible. Unoccupied habitat within metapopulations also should be protected to facilitate seed dispersal and pollinator movement. Thus, additional elements of the strategy are to protect land in blocks of at least 65 hectares (160 acres) and to avoid fragmenting any metapopulation into more than two blocks of contiguous, protected natural land. Buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences, provide pollinator habitat, and allow for population expansion. Finally, the natural hydrological regime, including appropriate height of the water table and periodic overland flows, must be maintained to ensure long-term survival of palmate-bracted bird's-beak at protected sites.

To prevent the irreversible decline of palmate-bracted bird's-beak in the near future, the Springtown Alkali Sink metapopulation must be protected from development and from incompatible uses. In addition, appropriate measures must be taken to protect and restore the hydrology after the Questa Engineering Corporation hydrologic study has been completed. Another high-priority task is to ascertain the genetic composition of the Woodland population. If it contains genes that differ from those in populations that are protected currently, the Woodland site should be considered for protection as a specialty reserve. If permitted development results in the loss of any natural populations, seeds should be salvaged for introduction into other suitable habitats. The occupied habitat on public land also is important to the survival of palmate-bracted bird's-beak; management to promote the continued survival of this species must continue.

Additional actions that are necessary, but of somewhat lower priority, are to determine the genetic composition and extent of the population in western Madera County, conduct surveys, develop management plans for all sites, and model population viability. The occupied habitat in Madera County is not in imminent danger of destruction, but the area is important for recovery of a number of plant and animal taxa, and long-term protection should be assured through conservation easements or other mechanisms. If the genetic variability or population size of palmate-bracted bird's-beak in the western Madera County site is low, techniques that can be used to increase population viability include augmentation (with seeds from other San Joaquin Valley populations) and habitat management. Management plans must be developed and implemented for each of the metapopulations. The plans should include monitoring to track population trends and evaluate management effectiveness. Seed samples should be collected from at least the Springtown, Woodland, and Alkali Sink/Mendota populations following established guidelines (Center for Plant Conservation 1991) to preserve the gene pool and provide sources for reintroduction or augmentation of populations, if determined to be necessary. Matrix projection models should be developed for the Springtown Alkali Sink and San Joaquin Valley populations, as well as for any others not currently known that are counted towards recovery. To do so, demographic studies must be instituted in these populations to identify critical stages in the life cycle. Additional research may be necessary to determine appropriate management to overcome limitations to population growth.

C. KERN MALLOW
(EREMALCHE KERNENSIS)

1. Description and Taxonomy

Taxonomy.—Kern mallow was first described as *Eremalche kernensis*, based on a specimen from the "Temblor Valley, 7 miles. northwest of McKittrick", in Kern County (Wolf 1938, p.67). Both Kearney (1951) and Munz (1958) transferred this species to the genus *Malvastrum* then reconsidered (Kearney 1956, Munz 1968) and returned to the original name. Other combinations have been suggested (Leonelli 1986) but were not validly published. The most recently-published treatments (Bates 1992, 1993) assign Kern mallow the name *Eremalche parryi* ssp. *kernensis*. However, the taxonomy of Kern mallow remains controversial in terms of its rank and its relationship to Parry's mallow (*Eremalche parryi* ssp. *parryi*). Most local botanists continue to use the scientific name *Eremalche kernensis* (Medlin in litt. 1995*a*) for this member of the mallow family (Malvaceae).

Description.—The height and habit of Kern mallow (Figure 9) vary depending on seasonal precipitation. The form can vary from single-stemmed to multiple-stemmed, with the central stem erect and the lateral stems trailing along the ground. Stem lengths at flowering may range from less than 2.5 centimeters (1 inch) to nearly 50 centimeters (20 inches). The flowers have five petals, and the wheel-shaped fruits are divided into single-seeded segments (Bates 1993).

Identification.—The taxonomic debate centers around the gender, color, and size of flowers indicative of Kern mallow versus Parry's mallow. Some populations in the Kern/Parry's mallow complex exhibit a condition known as *gynodioecy*, meaning that a population contains a mixture of plants that have only *pistillate* (female) flowers and plants that have only *bisexual* flowers (with both male and female parts). Bates (1992, 1993) considered any gynodioecious population in the Kern/Parry's mallow complex to be Kern mallow and those populations with only bisexual flowers to be Parry's mallow. On the other hand, Taylor and Davilla (1986) maintained that both Kern mallow and Parry's mallow were gynodioecious. Neither Wolf (1938) nor authors of early regional floras (Abrams 1951, Munz and Keck 1959) mentioned flower gender. Bisexual Kern mallow flowers produce fewer seeds per fruit (7 to 13) than do pistillate flowers (8 to 19). Parry's mallow and desert mallow (*Eremalche exilis*) fruits contain 10 to 22 and 9 to 13 segments, respectively (Abrams 1951, Munz and Keck 1959, Bates 1992, 1993, Mazer et al. 1993).

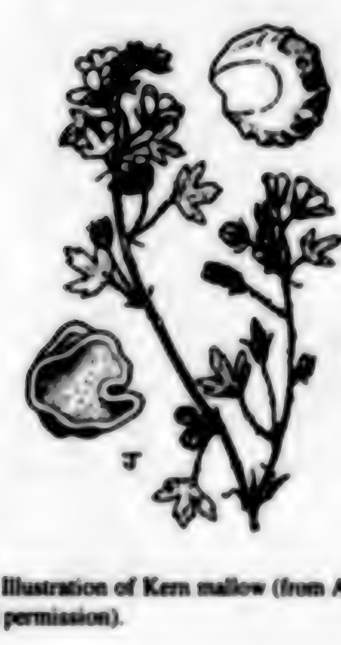

Figure 9. Illustration of Kern mallow (from Abrams, Vol. 3, 1951, with permission).

The strictest definition of Kern mallow applies only to populations in which white-flowered individuals predominate. Even in these areas, a few individuals may have pale lavender flowers (Wolf 1938, Bates 1992, Mazer et al. 1993), but lavender-flowered plants represented less than 10 percent of one population in 1994 (E. Cypher unpubl. data). Definite Parry's mallow populations consist of only pinkish-purple flowers, whereas those of questionable taxonomic affinity contain either exclusively pinkish-purple flowers or a very small proportion of white-flowered plants. Regardless of color, pistillate flowers have shorter petals than bisexual flowers in the same population (Bates 1992, 1993). Parry's mallow has larger flower parts than Kern mallow. Another closely-related species that infrequently occurs with the other two taxa is desert mallow, which has trailing stems and bisexual flowers that are smaller than those of Kern mallow (Twisselmann 1956, Twisselmann 1967, Hoover 1970, Bates 1993). The populations of Kern mallow that are predominantly white-flowered are the object of conservation concern, and thus the strict interpretation is used in the following sections unless otherwise noted.

2. Historical and Current Distribution

Historical Distribution.—Kern mallow has always had a highly-restricted distribution. In the original description, Wolf (1938) mentioned specimens from the Temblor Valley, Belridge Oil Field, and two sites west of Buttonwillow; all these occurrences were in *western Kern County* north of McKittrick.

Current Distribution.—A 1986 status survey reported three additional occurrences in Lokern, which is the local name for the area between Buttonwillow and McKittrick (Taylor and Davilla 1986). More intensive surveys during the past few years (Anderson et al. 1991, Olson and Magney 1992, CDFG 1995, Stebbins et al. 1992, S. Carter pers. comm.) revealed that Kern mallow occurs intermittently within an area of approximately 100 square kilometers (40 square miles) in Lokern, which is best described as a single metapopulation (Figure 10). The California Native Plant Society (Skinner and Pavlik 1994) and CDFG (1995) also accept reports of plants from three sites between Maricopa and McKittrick (in extreme western Kern County) as representing Kern mallow. Because specimens are not available to determine the color of the flowers and these sites are outside of the accepted range, they are treated here as representing Parry's mallow.

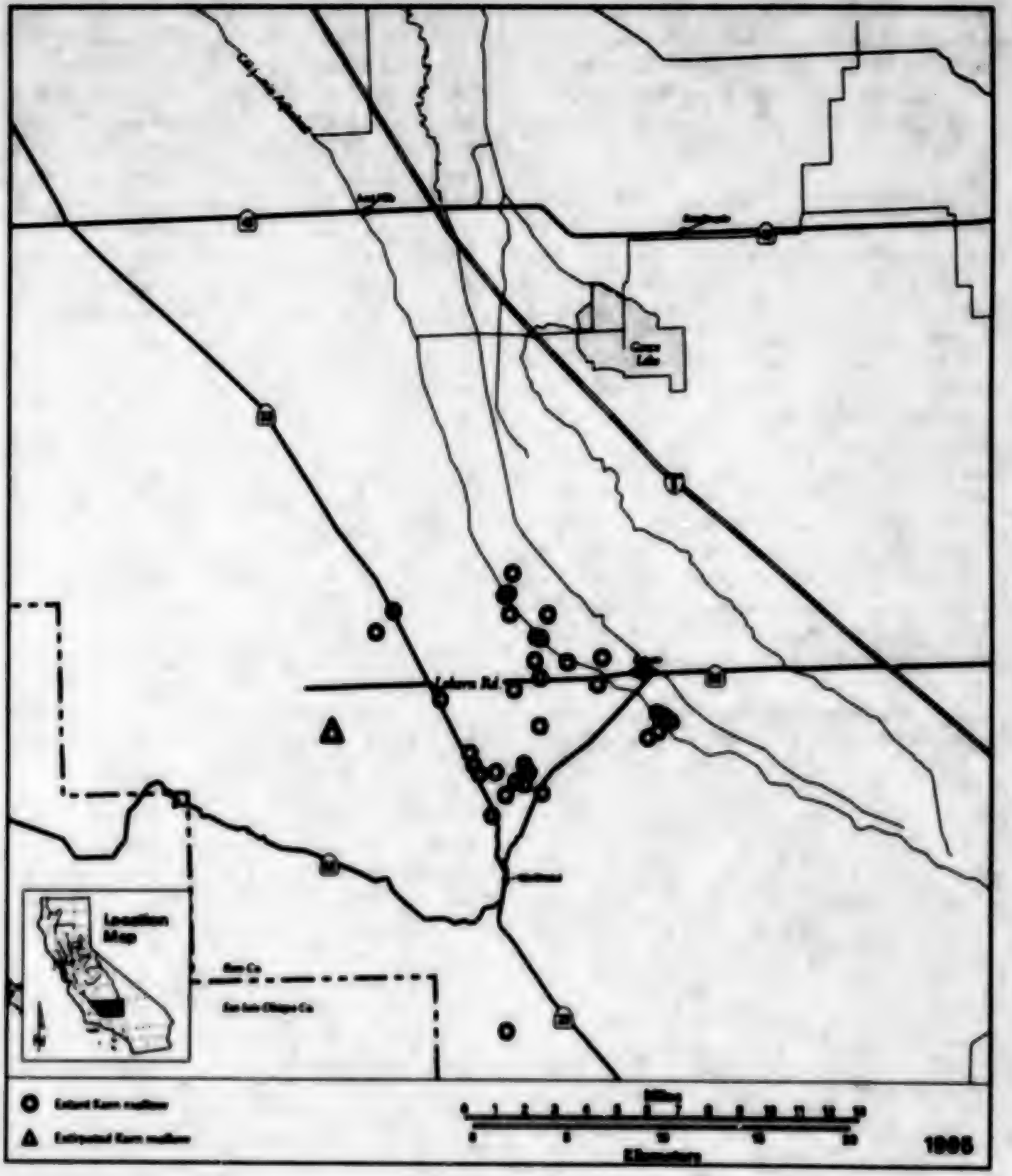

Figure 10. Distribution of Kern mallow (*Eremalche kernensis*).

Pink-flowered plants fitting Bates' (1992, 1993) broader concept of Kern mallow are widespread. Recent reports indicated that these plants occurred in several areas of Kern County, including Buena Vista Valley, Elk Hills, Lost Hills, McKittrick Hills, Stockdale, and the Temblor Range. Recent and historical reports elsewhere included Corcoran in Kings County; the Carrizo Plain, Elkhorn Plain, Panorama Hills, and Temblor Range in San Luis Obispo County; the Cuyama Valley in Santa Barbara County; and Pixley in Tulare County (Hoover 1970, Leonelli 1986, Olson and Magney 1992, Skinner and Pavlik 1994, CDFG 1995, Taylor and Davilla 1986, E. Cypher unpubl. observ., S. Wilson pers. comm.). Parry's mallow ranges from Alameda to Ventura Counties (Bates 1992).

3. Life History and Habitat

As with many arid-land annuals, the form, density, *phenology* (timing of different stages in the life cycle), and reproduction of Kern mallow vary greatly depending on precipitation.

Reproduction and Demography.—In Lokern, Kern mallow seeds typically germinate in January and February, and the plants begin flowering in March. Fruit production begins within a few days after flowers appear; flower and fruit production may continue into May if sufficient moisture is available. The seeds fall from the fruits as soon as they are mature. Seeds are capable of germinating in the following growing season, but at least some remain ungerminated. The duration of seed viability in the soil is not known. Seed dispersal agents are unknown but probably include animals and wind (Taylor and Davilla 1986, Mazer et al. 1993, E. Cypher unpubl. observ.).

Preliminary studies showed that insects facilitated pollination of Kern mallow. However, small numbers of seeds were produced when pollinators were excluded, even in pistillate plants which did not produce pollen. Possible explanations for this phenomenon were *apomixis* (i.e., seed set without fertilization), contamination of the test plants by researchers, or wind pollination. However, a higher frequency of seed set would have been expected if pollen was carried by the wind (Mazer et al. 1993). The native solitary bee species *Diadasia laticauda* is one potential pollinator of Kern mallow. This bee species occurs in Kern County and is known to visit mallows of the genus *Eremalche*. Furthermore, many bees of the genus *Diadasia* restrict their pollen collection to members of the mallow family (Thorp in litt. 1998).

Population size of Kern mallow varies with rainfall. Several botanists familiar with this species were unable to find Kern mallow at known locations in years of below-average rainfall (Wolf 1938, Twisselmann 1956, Bates 1992). In Lokern, Kern mallow density was nearly 10 times as high in 1995, a year of much higher than average rainfall, as in 1994, which had below-average rainfall during the growing season. Similarly, the number of flowers per plant ranged from 1 to 8 in 1994 and from 1 to over 700 in 1995 (E. Cypher unpubl. data.).

Habitat and Community Associations.—Kern mallow typically occurs in the Valley Saltbush Scrub natural community, where it grows under and around spiny and common saltbushes and in patches with other herbaceous plants, rather than in the intervening alkali scalds. Associated herbs include red brome, red-stemmed filaree (*Erodium cicutarium*), woolly goldfields (*Lasthenia minor*), and white Sierran layia (*Layia pentachaeta* ssp. *albida*). Kern mallow typically grows in areas where shrub cover is less than 25 percent (Taylor and Davilla 1986). The amount of herbaceous cover varies with rainfall and microhabitat; in occupied areas of Lokern, herbaceous cover averaged 80 percent in 1993 and 48 percent in 1994 (Cypher 1994*a*, 1994*b*, E. Cypher unpubl. data). Kern mallow occasionally has reinvaded disturbed sites when existing populations remained in adjacent areas to provide sources of seed (Mitchell 1989, E. Cypher unpubl. observ.).

Kern mallow occurs on alkaline sandy loam or clay soils at elevations of 95 to 275 meters (315 to 900 feet) (Wolf 1938, CDFG 1995). Leonelli's (1986) comparison of Kern mallow habitat in Lokern with Parry's mallow habitat in the Temblor Range revealed that Kern mallow grew on soils that were more alkaline, less saline, and less sandy than those where Parry's mallow grew.

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—The loss and degradation of habitat in the Lokern area have been responsible for the decline of Kern mallow. Construction of the California aqueduct impacted Kern mallow both directly, by destroying plants in its path, and indirectly, by providing water that allowed cultivation of cotton and alfalfa in the area of endemism. The western portion of Lokern was developed for petroleum production, which eliminated Kern mallow at the type locality. Two disposal facilities for liquid waste were constructed in occupied habitat. Causes of habitat degradation, not only in Lokern, but also in the populations south to Maricopa, included installation of pipelines and transmission lines and off-road vehicle use (CDFG 1995, Taylor and Davilla 1986).

Threats to Survival.—Approximately 85 percent of the Kern mallow habitat in Lokern is privately owned and thus is vulnerable to development for many potential uses (CDFG 1995, Taylor and Davilla 1986, Presley 1994). Although the current level of petroleum production does not seem to pose a threat to the portion of the metapopulation that remains, increased production levels could cause further fragmentation and loss of localized colonies of Kern mallow. Ongoing activities such as oil exploration and maintenance of pipelines and utility corridors continue to disturb occupied habitat. The maximum levels of development and habitat disturbance that would be compatible with the continued existence of Kern mallow are unknown. A more remote threat is the possibility of spills from tank trucks traveling through the area on highways and roads.

Paradoxically, both uncontrolled grazing and cessation of grazing have the potential to threaten the Kern mallow metapopulation. Sheep have grazed the Lokern area for decades (Presley 1994) and continue to graze on private lands during the growing season (E. Cypher pers. observ.). Grazing reduces the number of stems and branches on Kern mallow plants, which in turn reduces reproductive output (Mazer et al. 1993). In addition, trampling is likely to lead to localized destruction of Kern mallow in bedding areas where sheep are concentrated (Taylor and Davilla 1986). However, light to moderate grazing may serve to reduce competition in areas that are dominated by aggressive exotics (Cypher 1994*b*). Demographic studies indicated that the survival rate of Kern mallow seedlings was reduced in dense stands of exotic plants compared to sparsely-vegetated sites (Cypher 1994*b*). Furthermore, flower production was significantly increased in preliminary experiments where competitors were reduced through clipping (E. Cypher unpubl. data). The overall effects of sheep grazing on Kern mallow populations are unknown and require further investigation to determine appropriate management for the area.

Application of malathion in Lokern or other pesticides on adjacent agricultural fields could pose a threat to the long-term survival of Kern mallow by reducing pollinator populations. Malathion is sprayed periodically on natural lands in the San Joaquin Valley to control the beet leafhopper, which transmits diseases to crops (Clark 1991). Although current permit conditions for the California Department of Food and Agriculture prohibit malathion spraying within 1.6 kilometers (1 mile) of Kern mallow occurrences, research has not been conducted to determine whether or not this buffer size is adequate. If pollinator numbers were reduced, the Kern mallow metapopulation likely would experience reduced seed-set (Mazer et al. 1993). Also, if apomixis was the primary source of seeds, genetic variability could decline and the metapopulation could be more vulnerable to disease or other catastrophic events, such as has been observed in common species (Burdon and Marshall 1981).

5. Conservation Efforts

Kern mallow was federally listed as endangered in 1990 (USFWS 1990; Table 1). Even before then, Lokern was a focus for protection because a variety of endangered and threatened species occupy the area. The California Energy Commission, California Department of Water Resources, and USBLM have sponsored biological surveys in Lokern (Anderson et al. 1991, Stebbins et al. 1992, S. Carter pers. comm.). Approximately 15 percent of the occupied Kern mallow habitat, primarily on the margins of the metapopulation, is owned by USBLM and The Nature Conservancy. An interagency cooperative acquisition and management plan for the entire 17,800-hectare (44,000-acre) Lokern Conceptual Area is in draft form; participants include USBLM, CDFG, California Energy Commission, The Nature Conservancy, Center for Natural Lands Management, and USFWS. Chevron USA may contribute to preservation of the area by establishing a mitigation bank on its lands, which constitute approximately 40 percent of the conceptual area and a substantial portion of the Kern mallow habitat (Presley 1994). The draft Kern County Valley Floor Habitat Conservation Plan specifies that no more than 10 percent of the natural land in the Lokern Conceptual Area may be disturbed under its section 10(a)(1)(B) permit (T. James pers. comm.), but protection efforts would not necessarily target occupied Kern mallow habitat.

Efforts that specifically targeted the conservation of Kern mallow included (1) research on the demography and reproductive biology of Kern mallow funded by

C[illegible] (Mazer et al. 1993), (2) salvage of plant specimens and seed from the Laidlaw Waste Disposal Facility by Endangered Species Recovery Program and Laidlaw in cooperation with USFWS, (3) ongoing population monitoring and research on the response of Kern mallow to cattle grazing jointly sponsored by the Biological Resources Division of the U.S. Geological Survey, USBLM, USFWS, the Endangered Species Recovery Program, CDFG, and other agencies, corporations, and organizations, and (4) exclusion of grazing from known Kern mallow habitat under the control of USBLM and Center for Natural Lands Management.

6. Recovery Strategy

Considering that habitat loss is the primary reason that Kern mallow is listed as an endangered species, the top-priority task for recovery is to protect habitat in Lokern. The goal is to protect 90 percent of the remaining occupied habitat. This goal is based on the recognition that some development in Lokern must be allowed for economic reasons and on the assumption that loss of an additional 10 percent of the habitat will not jeopardize the continued survival of the taxon, provided that the protected habitat is managed appropriately. Unoccupied habitat within the metapopulation also is important for population expansion and movement of pollinators and seed dispersers. Thus, additional elements of the strategy are to protect land in blocks of at least 65 hectares (160 acres) and to avoid fragmenting the metapopulation into more than two blocks of contiguous, protected natural land. Buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion.

The long-term prospects for survival of Kern mallow would be enhanced if more than one metapopulation was protected. The preferred approach is to determine the identity of the questionable populations in other areas and protect any others that are identified through biosystematic analysis as Kern mallow, rather than to attempt artificial introductions. However, the decision as to whether to protect existing populations outside of Lokern or to plant seeds from Lokern at other sites depends on the outcome of systematic research. A *biosystematic study* (research that uses evidence from several disciplines to determine taxonomic affiliations) should be completed within 5 years of recovery plan approval. Moreover, if the pink-flowered and white-flowered mallow populations are determined to represent a single taxon, the listing status for Kern mallow would need to be reevaluated.

Additional high-priority tasks are to continue demographic and ecological research. Demographic studies are a prerequisite to matrix projection modeling, which is necessary to identify vulnerable stages in the life cycle. Only if these limiting stages are managed properly can populations be assumed to be self-sustaining (Schemske et al. 1994). Research is required to determine the relative magnitude of threats posed by exotic plants and sheep and to formulate appropriate management strategies for all protected lands. Even after demographic studies are discontinued, population trends should be monitored annually and management strategies should be reassessed if the Lokern metapopulation begins to decline. Several important aspects of pollination ecology must be investigated in greater detail, including the identity of insect pollinators, their vulnerability to pesticides that are used locally, and other mechanisms of pollen transfer. Until more specific recommendations are available from research, pollinator availability should be considered a limiting factor and pesticide spraying should be avoided in Lokern during the Kern mallow flowering period.

D. HOOVER'S WOOLLY-STAR
(ERIASTRUM HOOVERI)

1. Description and Taxonomy

Taxonomy.—Hoover's woolly-star was named originally by Jepson (1943) as *Huegelia hooveri*. In a later taxonomic revision, Mason (1945) assigned the currently-accepted name of *Eriastrum hooveri* to the species. Both the scientific and common names honor Robert F. Hoover, who collected the type specimen in 1937 in Kern County, 11 kilometers (7 miles) south of Shafter (Mason 1945). Hoover's woolly-star is an inconspicuous member of the phlox family (Polemoniaceae).

Description.—The wiry stems of this species may or may not branch and vary in height from 1 to 20 centimeters (0.4 to 8 inches) at flowering (Figure 11). The leaves are thread-like and may have two narrow lobes near the base. Hoover's woolly-star has tiny (less than 5 millimeters; less than 0.2 inch long), white to pale blue flowers that are nearly hidden in tufts of woolly hair. The *stamens* (male reproductive parts) are shorter than the corolla (Abrams 1951, Munz and Keck 1959, Patterson 1993, Taylor and Davilla 1986, Lewis 1992).

Identification.—Many-flowered eriastrum (*Eriastrum pluriflorum*) frequently occurs with Hoover's woolly-star; the former has dark blue flowers that are 16 millimeters (0.6 inch) or greater in length, stamens that protrude from the corolla, and leaves with up to 10 lobes. Small-flowered *Eriastrum* species that occur within the same range are distinguished from Hoover's woolly-star by flower color and stamen length (Abrams 1951, Munz and Keck 1959, Patterson 1993, Taylor and Davilla in litt. 1986, Lewis 1992).

2. Historical and Current Distribution

Historical Distribution.—Prior to 1986, Hoover's woolly-star was known from 19 sites in 4 counties, based on herbarium collections and written observations. The majority of the occurrences were on the San Joaquin and Cuyama Valley floors, and the others were from the low mountains at the west side of the San Joaquin Valley (Figure 12). In Kern County, Hoover's woolly-star was known from the vicinities of Lokern, Oildale, Semitropic, Shafter, and the Temblor Range. In Fresno County, known occurrences were concentrated near Kerman, Mendota, and Raisin City, except for one site each in the Jacalitos and Panoche Hills. The Cuyama Valley records consisted of one collection each from Santa Barbara and San Luis Obispo Counties (Taylor and Davilla 1986).

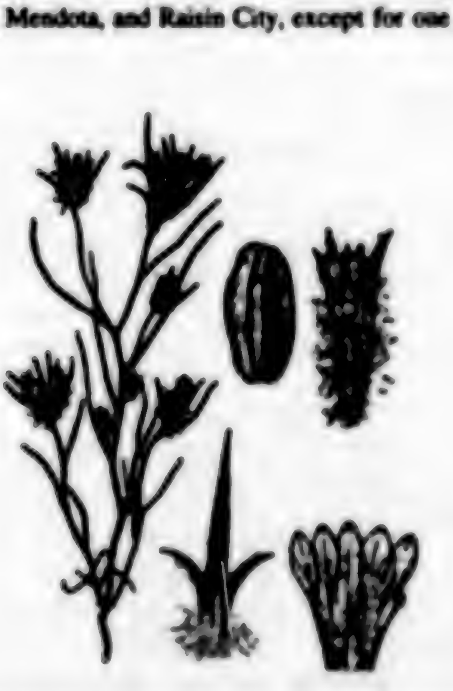

Figure 11. Illustration of Hoover's woolly-star (from Abrams, Vol. 3, 1951, with permission).

Current Distribution.—Hoover's woolly-star since has been discovered in Kings and San Benito Counties and at numerous additional sites in the four original counties, particularly in foothill areas. Most of the occurrences are concentrated in 4 metapopulations. In descending order by estimated number of individuals, these metapopulations are (1) the Kettleman Hills in Fresno and Kings Counties, (2) Carrizo Plain - Elkhorn Plain - Temblor Range - Caliente Mountains - Cuyama Valley - Sierra Madre Mountains in San Luis Obispo, Santa Barbara, and extreme western Kern Counties, (3) Lokern - Elk Hills - Buena Vista Hills - Coles Levee - Taft -Maricopa in Kern County, and (4) Antelope Plain - Lost Hills - Semitropic in Kern County. Small, isolated populations occur in scattered areas including the Alkali Sink Ecological Reserve and the Guijarral, Jacalitos, Panoche, and Tumey Hills in Fresno County; Buttonwillow, Devil's Den, Lamont, Midway Valley, and Rosedale in Kern County; and the Panoche Hills in San Benito County (Lewis 1992, 1994, CDFG 1995, Holmstead 1993, Danielsen et al. 1994, EG&G Energy Measurements 1995*a,b*). According to Skinner and Pavlik (1994), the species also occurs in Tulare County.

3. Life History and Habitat

Reproduction and Demography.—Hoover's woolly-star is an annual, but the seeds germinate later in the growing season than do those of many of the associated annual plants. Seedlings may emerge from January or February until mid-April (Taylor and Davilla 1986, E. Cypher unpubl. data). The typical flowering period for Hoover's woolly-star extends from March into June (Munz and Keck 1959, Skinner and Pavlik 1994, Lewis 1992, Cypher 1994*a*). Pollination ecology has not been investigated. However, other members of the genus *Eriastrum* are pollinated by native bees (superfamily Apoidae) and beeflies (family Bombyliidae) (Grant and Grant 1965). The tiny seeds probably are dispersed by wind or by tumbling of dead stems (Taylor and Davilla 1986). Unlike many other annuals, dead stems of Hoover's woolly-star may persist until the next growing season (Lewis 1992).

Within metapopulations, Hoover's woolly-star typically occurs as scattered groups of plants, with each

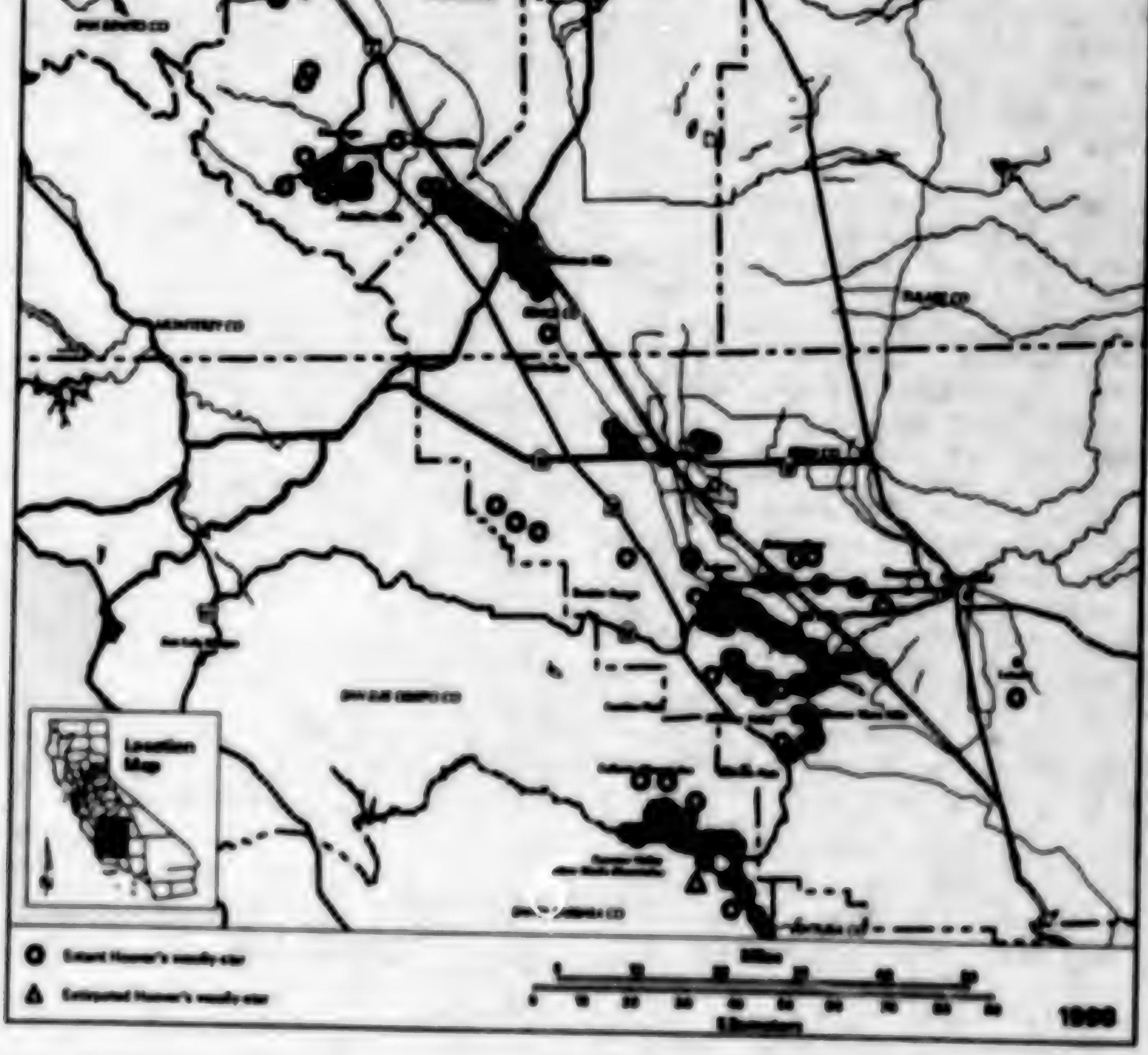

Figure 12. Distribution of Hoover's woolly-star (*Eriastrum hooveri*).

group occupying an area of less than 0.4 hectare (1 acre) (Lewis 1994). Densities are highly variable among sites and among years. In 1993, average densities reported for Hoover's woolly-star in occupied habitat were 3.6 per square meter (0.3 per square foot) at Elk Hills (EG&G Energy Measurements unpubl. data), 8.4 per square meter (0.8 per square foot) in Lokern, and 10.3 per square meter (0.9 per square foot) in the Kettleman Hills (Cypher 1994*a*). However, metapopulation densities would be considerably smaller due to the presence of unoccupied stretches between the groups of plants. Densities of Hoover's woolly-star fluctuate from year to year and are highest in years of above-average precipitation (Holmstead 1993). At Elk Hills, densities in natural colonies were 5 to 15 times greater in 1993, a year of above-average rainfall, than in 1991, which was a year of average rainfall (EG&G Energy Measurements 1995*a,b*).

Habitat and Community Associations.—Hoover's woolly-star seems to be much more adaptable than other endemic plants of the San Joaquin Valley. Optimal habitats for Hoover's woolly-star are characterized by stabilized silty to sandy soils, a low cover of competing herbaceous vegetation, and the presence of *cryptogamic crust* (a layer of moss, lichen, and algae). However, this species also has been found on loamy soils, in areas of dense vegetation, and in areas lacking cryptogamic crust (Taylor and Davilla 1986, Cypher 1994*a*, Lewis 1994, EG&G Energy Measurements 1995*a,b*). Hoover's woolly-star may reinvade disturbed soil surfaces such as well pads and dirt roads within 1 year after the disturbance ceases if seed sources remain in the vicinity (Holmstead 1993, Danielsen et al. 1994, EG&G Energy Measurements unpubl. data, R. Lewis pers. comm.). In fact, this species may benefit from light to moderate soil disturbance in areas that are densely vegetated by exotic plants (Holmstead and Anderson 1993, EG&G Energy Measurements unpubl. data).

Populations of Hoover's woolly-star occur in alkali sinks, washes, on both north- and south-facing slopes, and on ridgetops. This species occurs in a wide variety of plant communities. Most are characterized by shrubs such as common saltbush, seepweed, and matchweed (*Gutierrezia californica*), but shrub cover in occupied habitats typically is less than 20 percent. Herbaceous plant species frequently found in association with Hoover's woolly-star include red brome, goldfields, many-flowered eriastrum, and red-stemmed filaree. Populations of Hoover's woolly-star have been reported at elevations ranging from 50 to 915 meters (165 to 3,000 feet) (CDFG 1995, Taylor and Davilla 1986, Holmstead 1993, Cypher 1994*a*, Danielsen et al. 1994, Lewis 1992, 1994, EG&G Energy Measurements 1995*a,b*).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—Valley-floor populations of Hoover's woolly-star have been destroyed primarily by farming operations and secondarily by urban development (Taylor and Davilla 1986, E. Cypher pers. observ.).

Threats to Survival.—Occurrences of Hoover's woolly-star in the vicinity of Buttonwillow, Lost Hills, Rosedale and sites along Interstate Highway 5 are threatened by commercial development. Agricultural conversion continues to threaten several populations on the Valley floor. Flooding, as a result of high precipitation, groundwater recharge programs, agricultural wastewater diversion, or waterfowl management, could destroy populations in low-lying areas (Skinner and Pavlik 1994, Taylor and Davilla 1986). Dense growth of associated vegetation, such as in areas where exotic grasses dominate or where fire has been suppressed, may create unsuitable conditions for growth of Hoover's woolly-star (J. Hinshaw pers. comm.). Hoover's woolly-star remains primarily in hilly areas, many of which are oil fields; petroleum production does not pose a threat in most cases but could be detrimental if large areas of occupied habitat were disturbed. The acquisition of Elk Hills by Occidental Petroleum may lead to greater surface disturbance if rates of exploration and production are increased.

5. Conservation Efforts

Hoover's woolly-star was federally listed as threatened in 1990 (USFWS 1990; Table 1). Field surveys sponsored by USBLM, California Energy Commission, U.S. Department of Energy, California Department of Water Resources, and USFWS resulted in the discovery of many new occurrences of Hoover's woolly-star between 1986 and 1997 (Anderson et al. 1991, Taylor and Davilla 1986, Lewis 1992, 1994, Stebbins et al. 1992, Holmstead 1993, EG&G Energy Measurements 1995*a,b*, Enterprise Advisory Services 1997, 1998). Through a consultation with USFWS, the U.S. Department of Energy conducted periodic monitoring of six representative Hoover's woolly-star sites at Elk Hills through 1997 (EG&G Energy Measurements 1995*a*, 1995*b*, 1996, Enterprise Advisory

Services 1997, 1998). Occidental Petroleum, the current owner of the Elk Hills oilfield, plans to set aside a conservation area containing Hoover's woolly-star, among other rare species (B. Cypher pers. comm.). In addition, U.S. Department of Energy has sponsored several research projects on the ecology of Hoover's woolly-star, its response to oilfield activity, and the conditions under which it will recolonize disturbed areas (Holmstead 1993, Holmstead and Anderson 1993, EG&G Energy Measurements 1995*a,b*, J. Hinshaw pers. comm.). Preliminary studies on the demography of Hoover's woolly-star and its response to grazing were conducted in 1993 with funding provided by USBLM, CDFG, and Endangered Species Recovery Program (Cypher 1994*a*). Hoover's woolly-star also has benefited from the acquisition of conservation lands for listed animals. It is known to occur on the Alkali Sink Ecological Reserve, Buttonwillow Preserve, Carrizo Plain Natural Area, Coles Levee Ecosystem Preserve, Lokern Natural Area, and Semitropic Ridge Preserve. In 1990, Mobil Oil Corporation constructed exclosures around Hoover's woolly-star on their lands in Lost Hills (Lewis 1994).

6. Recovery Strategy

Recovery of Hoover's woolly-star can be accomplished using public lands and other areas already dedicated for conservation. As with the other listed plants, the goal is to protect populations throughout the species' range and representing a variety of topographic positions and community types. Considering that habitat conversion is ongoing in valley-floor areas and that oil production could increase on public lands, the continued existence of populations cannot be assumed unless a specific commitment is made to protect them from incompatible uses. Some amount of unoccupied suitable habitat is important to allow population fluctuations among years, and a buffer zone is important to minimize external influences. Thus, a minimum block size of 16 hectares (40 acres) is recommended, with an average density of 625 Hoover's woolly-star plants per hectare (250 per acre). Monitoring must continue at representative sites within each metapopulation to determine trends. Management strategies and recovery needs should be reassessed if population densities at the monitoring sites decline over 3 or more successive years of above-average rainfall that are separated by 1 or more years of below-average rainfall.

E. SAN JOAQUIN WOOLLY-THREADS (*LEMBERTIA CONGDONII*)

1. Description and Taxonomy

Taxonomy.—In 1883, Gray named San Joaquin woolly-threads as *Eatonella congdonii*. The type specimen had been collected by Congdon near Deer Creek (Tulare County) in that same year. The current name, *Lembertia congdonii*, was published by Greene in 1897, who determined that San Joaquin woolly-threads should be separated from snowy eatonella (*Eatonella nivea*). Subsequent taxonomists have upheld Greene's taxonomy (Johnson 1993, Taylor 1989). San Joaquin woolly-threads is the sole species in the genus *Lembertia*, which is in the aster family (Asteraceae).

Description.—The common name "woolly-threads" is derived from the many long (up to 45 centimeters; 18 inches), trailing stems covered with tangled hairs. However, San Joaquin woolly-threads plants also can be tiny (less than 7 centimeters; less than 3 inches) and erect with a single stem (Cypher 1994*a*). The tiny, yellow flower heads are clustered at the tips of the stems and branches (Figure 13). Each flower head is approximately 6 millimeters (0.25 inch) long and contains two types of *florets* (the tiny flowers characteristic of the aster family); the four to seven outer florets differ in shape from the numerous inner florets. The two types of florets produce *achenes* (tiny, one-seeded fruits) that also differ in shape (Johnson 1993, Taylor 1989).

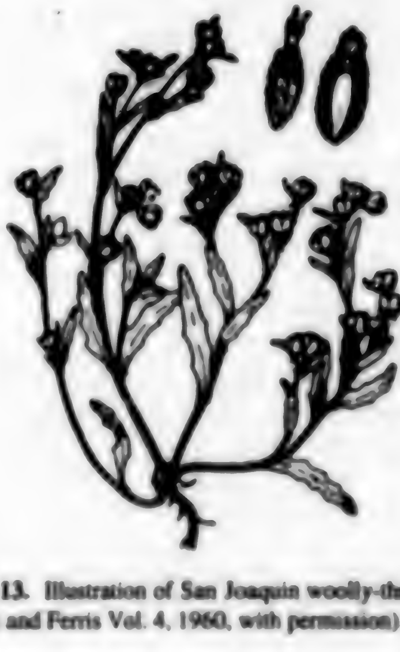

Figure 13. Illustration of San Joaquin woolly-threads (from Abrams and Ferris Vol. 4, 1960, with permission).

Identification.—San Joaquin woolly-threads differs from snowy eatonella in the shape of the florets and achenes and in geographical range (Munz and Keck 1959, Johnson 1993, Taylor 1989).

2. Historical and Current Distribution

Historical Distribution.—The historical range of San Joaquin woolly-threads is based on 47 herbarium specimens and literature reports dating from 1883 to 1983; 30 of the occurrences were from the floor of the San Joaquin Valley, four were from the Cuyama Valley, and the remainder were in the hills west of the San Joaquin Valley (Figure 14). These occurrences were concentrated in eight areas (in descending order of abundance): (1) the plains between Avenal and Mendota in Kings and Fresno Counties, (2) from Bakersfield to Shafter in Kern County, (3) the inner Coast Ranges of western Fresno and eastern San Benito Counties, (4) from north of Lokern to Lost Hills in Kern County, (5) the Carrizo and Elkhorn Plains in San Luis Obispo County, (6) the Cuyama Valley in Santa Barbara County, (7) east of Edison in Kern County, and (8) the type locality. However, 33 of the historical occurrences had been eliminated by 1989 (Taylor 1989).

Current Distribution.—Many new occurrences of San Joaquin woolly-threads have been discovered since 1986, primarily in the hills and plateaus west of the San Joaquin Valley. These constitute four metapopulations and several small, isolated populations. The largest metapopulation occurs on the Carrizo Plain Natural Area, where the occupied habitat totaled over 1,100 hectares (2,800 acres) in 1993 (R. Lewis 1993), which was a particularly favorable year. In years of lower rainfall, the occupied area is much smaller (E. Cypher unpubl. observ.). Much smaller metapopulations are found in Kern County near Lost Hills, in the Kettleman Hills of Fresno and Kings Counties, and in the Jacalitos Hills of Fresno County. The isolated occurrences are known from the Panoche Hills in Fresno and San Benito Counties, the Bakersfield vicinity, and the Cuyama Valley (CDFG 1995, Taylor 1989, Stebbins et al. 1992, R. Lewis 1993, Taylor and Buck 1993, USBLM in litt. 1994, S. Carter pers. comm., R. Lewis pers. comm., S. Wilson pers. comm.).

3. Life History and Habitat

Reproduction and Demography.—San Joaquin woolly-threads is an annual herb, and its phenology varies with weather and site conditions. In years of below-average precipitation, few seeds of this species germinate, and those that do typically produce tiny plants. Seed germination may begin as early as November but usually occurs in December and January. San Joaquin woolly-threads typically flowers between late February and early April, but flowering may continue into early May if conditions are optimal (B. Delgado pers. comm.). Populations in the northern part of the range flower earlier than does the Carrizo Plain metapopulation. Each plant may have from 1 to more than 400 flower heads. Seed production depends on plant size and the number of flower heads; in 1993, achene production ranged from 10 to 2,500 seeds per individual (Mazer and Hendrickson 1993*b*, Cypher 1994*a*, E. Cypher unpubl. data). The seeds are shed immediately upon maturity, and all trace of the plants disappears rapidly after their death in April or May. Seed dispersal agents are unknown, but possible candidates include wind, water, and animals. Seed-dormancy mechanisms apparently allow the formation of a substantial seed bank in the soil (Twisselmann 1967, Taylor 1989, R. Lewis 1993, Mazer and Hendrickson 1993*b*, Cypher 1994*a*).

Insect pollinators are not required for seed-set in San Joaquin woolly-threads (Mazer and Hendrickson 1993*b*). However, animals may be important to this plant species in other ways. On the Carrizo Plain Natural Area, giant kangaroo rat activity contributes to greater plant size and flower head production in San Joaquin woolly-threads, probably by increasing available soil nutrients and reducing competition from other plants. The microhabitat offered by giant kangaroo rat *precincts* also contributes to earlier seed germination and maturation of San Joaquin woolly-threads, possibly because precinct surfaces are warmer than the surrounding area during the winter months (Cypher 1994*a*, 1994*b*).

Habitat and Community Associations.—San Joaquin woolly-threads occurs in Nonnative Grassland, Valley Saltbush Scrub, Interior Coast Range Saltbush Scrub, and Upper Sonoran Subshrub Scrub (Cypher 1994*a*). This species typically occupies microhabitats with less than 10 percent shrub cover, although herbaceous cover may be either sparse or dense, and cryptogamic crust may or may not be present. Plant species that often occur with San Joaquin woolly-threads include red brome, red-stemmed filaree, goldfields, Arabian grass (*Schismus* spp.), and mouse-tail fescue (*Vulpia myuros*). Hoover's woolly-star often occurs in populations of San Joaquin

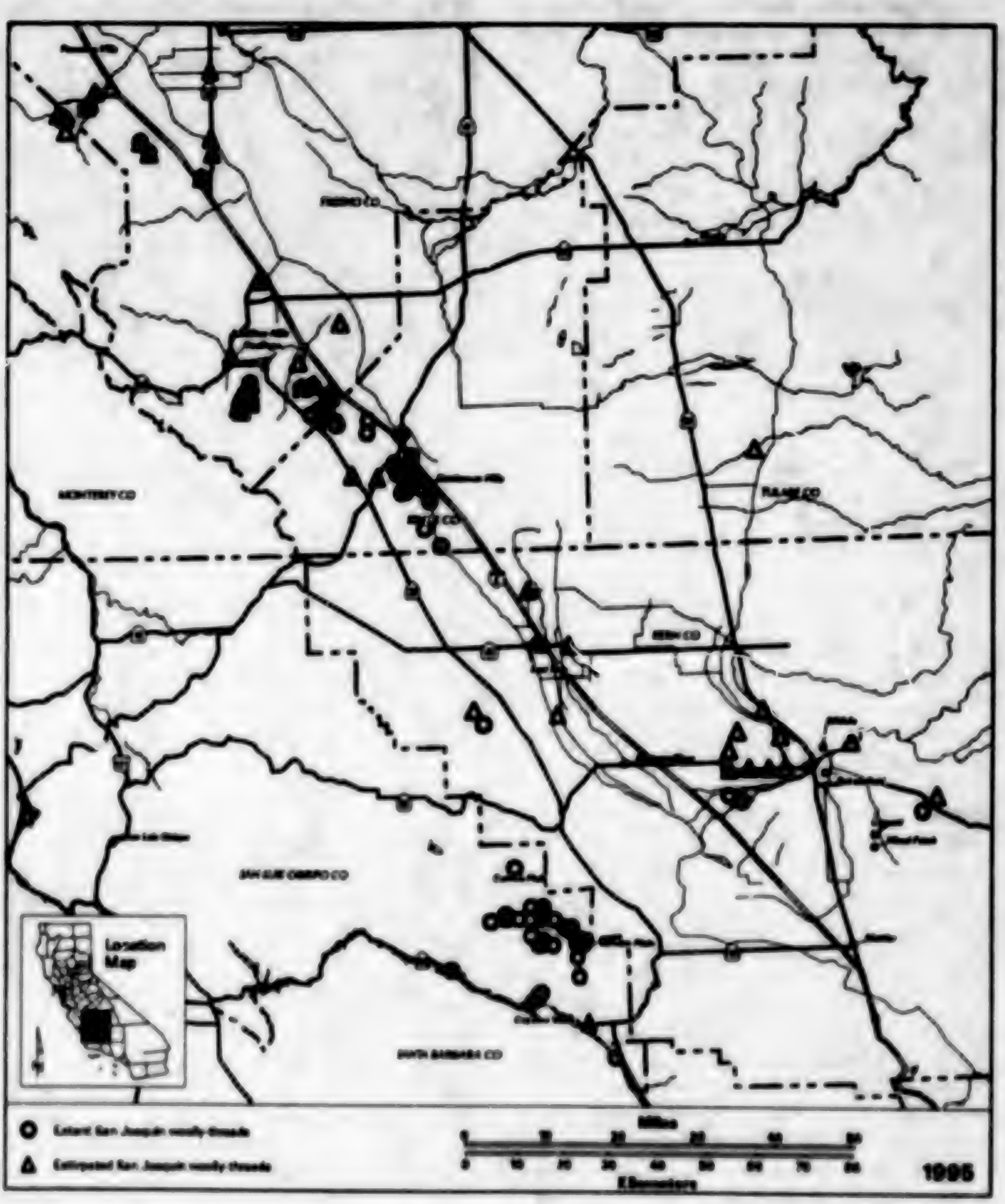

Figure 14. Distribution of San Joaquin woolly-threads (*Lembertia congdonii*).

woolly-threads, although the reverse is not true (Taylor 1989, R. Lewis 1993, Taylor and Buck 1993, Cypher 1994*a*). In two cases, San Joaquin woolly-threads was found at low densities in previously disced areas that were adjacent to undisturbed populations (R. Lewis 1993, Taylor and Buck 1993).

San Joaquin woolly-threads occurs on neutral to subalkaline soils that were deposited in geologic times by flowing water. On the San Joaquin Valley floor, this species typically is found on sandy or sandy loam soils, particularly those of the Kimberlina series, whereas on the Carrizo Plain it occurs on silty soils. San Joaquin woolly-threads frequently occurs on sand dunes and sandy ridges as well as along the high-water line of washes and on adjacent terraces. Occurrences have been reported at elevations ranging from approximately 60 to 260 meters (200 to 850 feet) on the Valley floor and surrounding hills, and from 600 to 800 meters (2,000 to 2,600 feet) in San Luis Obispo and Santa Barbara Counties (Hoover 1937, CDFG 1995, Taylor 1989, R. Lewis 1993, Taylor and Buck 1993, E. Cypher unpubl. observ., R. van de Hoek pers. comm.).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—Habitat loss was responsible for the decline of San Joaquin woolly-threads on the floors of the San Joaquin and Cuyama Valleys, where the majority of the occurrences were eliminated by intensive agriculture. In addition, several sites in and around Bakersfield were eliminated by urban development, and two others between Lokern and Lost Hills apparently were destroyed as a result of intensive oilfield development (CDFG 1995, Taylor 1989).

Threats to Survival.—The Lost Hills metapopulation is on private land in an area of high value for commercial development and agriculture (Taylor 1989, Taylor and Buck 1993). Several occurrences in the Kettleman Hills, the Jacalitos Hills, and west of Bakersfield are in low-density oilfields; the plants do not seem to be threatened by the current level of activity but could be destroyed by more intensive use of the areas (R. Lewis 1993, E. Cypher unpubl. observ.). Preliminary studies suggested that both competition from exotic plants and spring grazing reduced survival rates, but not flower production, in San Joaquin woolly-threads (E. Cypher unpubl. data). Trampling also reduces survival in areas where livestock congregate, such as around water troughs (Taylor 1989, R. Lewis 1993, Mazer and Hendrickson 1993*b*, Cypher 1994*a,b*, E. Cypher unpubl. data, B. Delgado pers. comm.). However, removal of livestock from areas that have been grazed continuously for decades would be inadvisable without additional data, because grazing may in fact be a useful management tool to control competition from exotic plants (E. Cypher unpubl. observ.).

5. Conservation Efforts

San Joaquin woolly-threads was federally listed as endangered in 1990 (USFWS 1990; Table 1). USBLM biologists have conducted extensive surveys for San Joaquin woolly-threads. Thus, many of the occurrences that are known currently are on lands administered by USBLM, including the entire Carrizo Plain Natural Area metapopulation, part of the Kettleman Hills metapopulation, and the sites in the Jacalitos and Panoche Hills. Within these areas, fences have been erected around several small occurrences of San Joaquin woolly-threads that showed evidence of trampling by livestock (R. Lewis 1993, S. Carter pers. comm., B. Delgado pers. comm.). The Carrizo and Elkhorn Plains and the Kettleman Hills are within Areas of Critical Environmental Concern, which would restrict activities on USBLM lands in those regions (USBLM 1996*a,b*). USBLM and the Endangered Species Recovery Program are cooperatively monitoring selected populations and conducting research on the impacts of livestock grazing (Cypher 1994*a,b*, USBLM in litt. 1994).

Other groups also are contributing to conservation of this species. CDFG funded research on the demography, reproductive biology, and ecology of San Joaquin woolly-threads (Mazer and Hendrickson 1993*b*, Cypher 1994*a*). California Energy Commission, U.S. Department of Energy, and California Department of Water Resources have sponsored surveys for rare plants, including San Joaquin woolly-threads, in various parts of the southern San Joaquin Valley (Anderson et al. 1991, Stebbins 1993, B.L. Cypher pers. comm.). The Metropolitan Bakersfield Habitat Conservation Plan identified a 121-hectare (300-acre) area west of Bakersfield as a preserve acquisition target for this species (Metropolitan Bakersfield Habitat Conservation Plan Steering Committee 1994). If the Kern County Valley Floor Habitat Conservation Plan is implemented as currently proposed, private landowners in the vicinity of Lost Hills would be offered incentives to protect San Joaquin woolly-threads habitat (T. James pers. comm.).

6. Recovery Strategy

The recovery goal for San Joaquin woolly-threads is similar to that for the other endangered plant species in this plan: to maintain self-sustaining populations in protected areas representative of the former geographic and topographic range of the species and in a variety of appropriate natural communities. A sufficient number of natural populations exist that reintroduction should not be necessary, provided that the existing sites are protected and managed properly. Unoccupied habitat within metapopulations also should be protected to allow for population fluctuations with rainfall and to facilitate seed dispersal. Thus, additional elements of the strategy are to protect land in blocks of at least 65 hectares (160 acres), which have an average density of at least 1,000 San Joaquin woolly-threads plants per hectare (400 plants per acre); and to avoid fragmenting any metapopulation into more than 2 blocks of contiguous, protected natural land. Finally, buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion.

The top-priority task to ensure the survival of San Joaquin woolly-threads is to protect existing habitat in the San Joaquin Valley. Other actions that are necessary for recovery include protection and appropriate management of populations on public land and annual monitoring of representative sites within each metapopulation. Monitoring is particularly important in some of the smaller populations, including the Lost Hills, Jacalitos Hills, and Kettleman Hills metapopulations and the Panoche Hills population to determine whether densities are increasing, decreasing, or remaining stable. Monitoring can verify that existing management strategies are having the desired effect or draw attention to incompatible land uses.

F. BAKERSFIELD CACTUS
(OPUNTIA BASILARIS VAR. TRELEASEI)

1. Description and Taxonomy

***Taxonomy*.**—The taxonomy of Bakersfield cactus has not been accepted universally, even though it was named nearly a century ago. Originally, Bakersfield cactus was treated as a full species, *Opuntia treleasii* (Coulter 1896). The type locality was given as "Caliente, in the Tehachapi Mountains" (Coulter 1896, p. 434), which is in Kern County. Shortly thereafter, Toumey (1901) renamed Bakersfield cactus as a variety of beavertail cactus (*Opuntia basilaris*), resulting in the combination *O. basilaris* var. *treleasii*. Griffiths and Hare (1906) considered Bakersfield cactus a distinct species and subdivided it into two varieties, *O. treleasii* var. *treleasii* and var. *kernii*. Britton and Rose (1920) corrected the spelling of the epithet to *treleasei* to be consistent with the name of the original collector, William Trelease. In the most recent treatment (Parfitt and Baker 1993), the scientific name of Bakersfield cactus is given as *O. basilaris* var. *treleasei*. However, some experts consider Bakersfield cactus to be a full species (Bowen 1987, R. van de Hoek pers. comm.).

***Description*.**—Like other beavertail cacti, Bakersfield cactus (Figure 15) has fleshy, flattened, green stems (*pads*). The pads of Bakersfield cactus vary in outline from rounded, heart-shaped, or diamond-shaped to nearly cylindrical. A single plant may consist of hundreds of pads, which originate both at ground level and from the tips of other pads. The number of individuals in a population may be difficult to determine because pads from adjacent plants often overlap. Thus, cactus populations usually are described by the number of *clumps* (groups of pads that are rooted at the same point) rather than as a number of individuals. Clumps of Bakersfield cactus can grow up to 35 centimeters (14 inches) high and 10 meters (33 feet) across (R. van de Hoek pers. comm.). The pads and fruits are dotted with

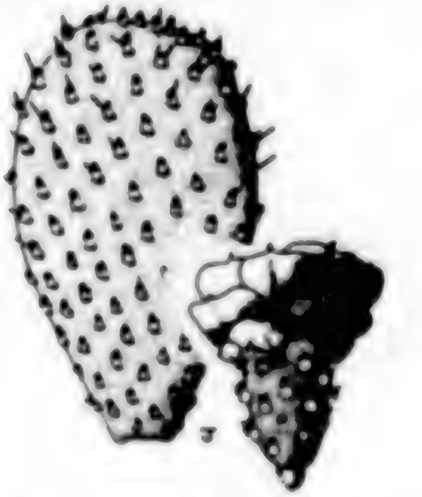

Figure 15. Illustration of Bakersfield cactus (from Abrams and Ferris, Vol. 3, 1951, with permission).

eye-spots, which are rounded structures that contain barbed bristles. Tiny leaves are produced on the youngest pads of beavertail cacti but are shed quickly. Bakersfield cactus has showy magenta flowers. The dry fruits are the size and shape of small eggs and may contain grayish-white seeds (Munz and Keck 1959, Parfitt and Baker 1993). Bakersfield cactus typically has 22 chromosomes, but plants with 33 chromosomes were found in several populations (Pinkava et al. 1977, R. van de Hoek pers. comm.).

Identification.—Bakersfield cactus is unique among the varieties of *O. basilaris* in that the eye-spots contain spines in addition to the bristles. Other features of Bakersfield cactus that differentiate it from related beavertail cacti include the smooth *pad* surfaces, cylindrical pad bases, nonsunken eye-spots, and longer (up to 5 millimeters [0.2 inch]) leaves. The two varieties of *O. treleasei* differ from each other in that variety *treleasei* has spines less than 7 millimeters (0.3 inch) long (which may be longer or shorter than the associated bristles) and eye-spots even with the pad surface, whereas variety *kernii* has spines longer than 7 millimeters (0.3 inch) and raised eye-spots (Griffiths and Hare 1906, ESA Planning and Environmental Services 1986*a*, Bowen 1987).

2. Historical and Current Distribution

Historical Distribution.—Bakersfield cactus is endemic to a limited area of central Kern County in the vicinity of Bakersfield. The CDFG (1995) considered the pre-1987 reports to represent approximately 33 occurrences. However, based on written descriptions (Twisselmann 1967), historical photographs (Britton and Rose 1920, Benson 1982), topography, and deductions from plant morphology, the populations most likely were more or less continuous (R. van de Hoek pers. comm.). As of 1987, the northern, southern, eastern, and western limits of the known range, respectively, were Granite Station (R. van de Hoek pers. comm.), Comanche Point, Caliente, and Oildale (CDFG 1995). Reported occurrences of Bakersfield cactus in Los Angeles and San Bernardino Counties, California, and Mohave County, Arizona (Benson 1969) have been attributed to misidentification of other cactus taxa (Bowen in litt. 1987).

Current Distribution.—Approximately one-third of the historical occurrences of Bakersfield cactus have been eliminated, and the remaining populations are highly fragmented. However, the range was extended to the south when several occurrences were discovered in the late 1980s in south-central Kern County, just north of Wheeler Ridge (Figure 16). The extant occurrences may be grouped into the following areas of concentration: (1) Caliente Creek drainage (Caliente-Bena Hills), (2) Comanche Point, (3) Cottonwood Creek, (4) Fairfax Road - Highway 178 - Highway 184 - Kern Bluffs - Hart Park, (5) Fuller Acres, (6) Granite Station, (7) mouth of Kern Canyon, (8) Oildale - Kern River Oil Field - Round Mountain Road (separated from area #4 by the Kern River), (9) Poso Creek, (10) Sand Ridge, and (11) Wheeler Ridge - Pleito Hills (CDFG 1995, Moe 1989).

3. Life History and Habitat

Few details on the life history of Bakersfield cactus are available. The fleshy stems, tiny, short-lived leaves, shallow root systems, and specialized physiology common to most members of the cactus family are adaptations to growth in arid environments (Benson 1982).

Reproduction and Demography.—Bakersfield cactus is a perennial. The life span of wild plants has not been determined, but clumps in cultivation at the Rancho Santa Ana Botanic Garden in Claremont, California, survived for 48 years, until extremely wet winter weather caused the pads to rot (R. van de Hoek pers. comm.). Bakersfield cactus typically flowers in May (Munz and Keck 1959). Reproductive biology of this taxon has not been studied, but certain other *Opuntia* species require cross-pollination for seed-set and many are pollinated by bees (Benson 1982, Spears 1987, Osborn et al. 1988). One potential pollinator of Bakersfield cactus is the native solitary bee *Diadasia australis* ssp. *california*, which is known to occur in Kern County and which specializes in collecting pollen from *Opuntia* species (Thorp in litt. 1998). *Vegetative reproduction*, which is the production of new plants from sources other than seed, is typical in Bakersfield cactus and several related species (Benson 1982). Fallen pads root easily if sufficient water is available (Twisselmann 1967, Benson 1982, Mitchell 1988), but Bakersfield cactus does not survive prolonged inundation (ESA Planning and Environmental Services 1986*a*). Bakersfield cactus produces seeds infrequently. Van de Hoek (pers. comm.) noted that the frequency of seed set in extant populations is similar to the proportion of seeds he observed in herbarium specimens. Cactus seeds require warm, wet conditions to germinate, a combination which is

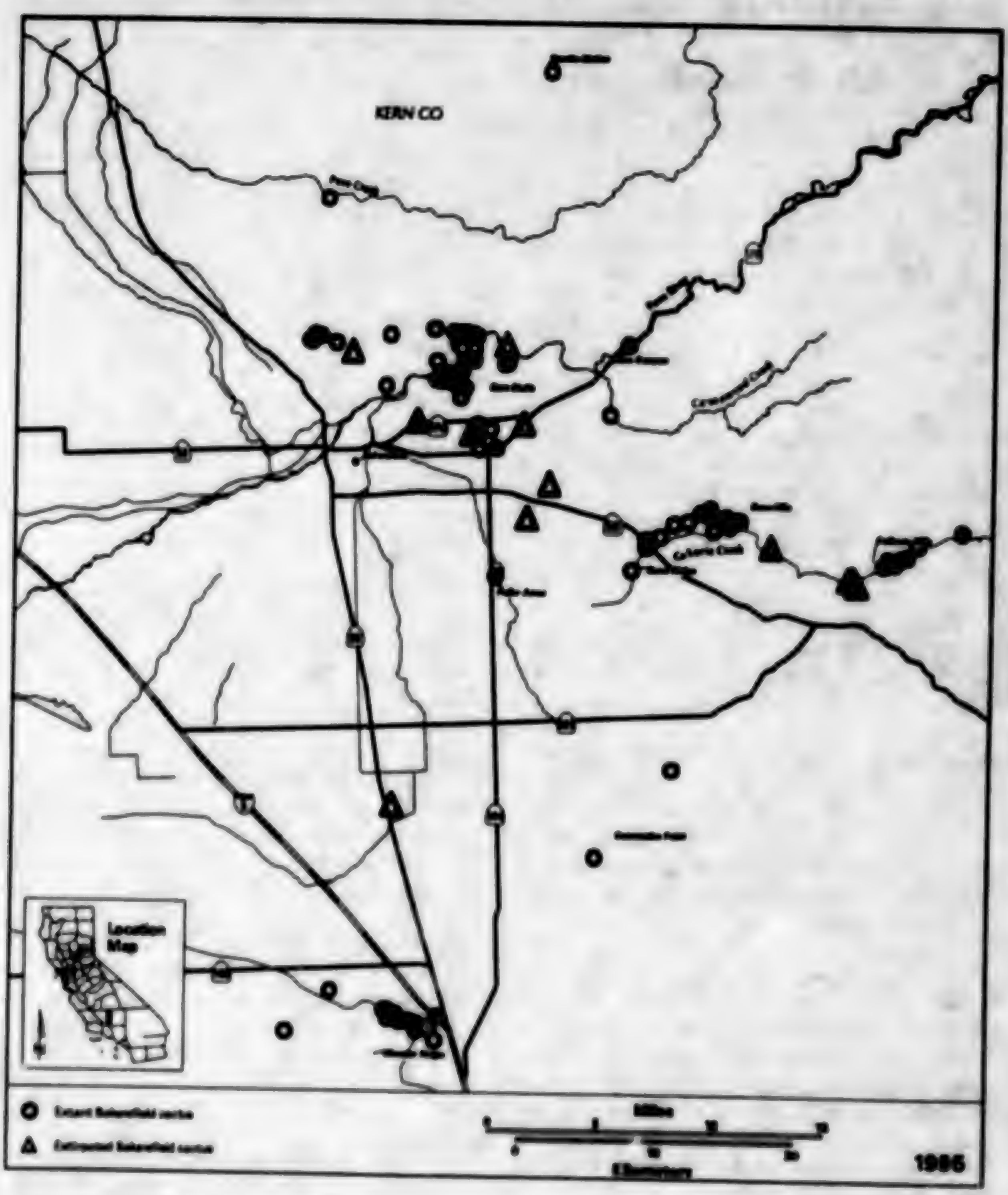

Figure 16. Distribution of Bakersfield cactus (*Opuntia basilaris* var. *treleasei*).

extremely rare in the Bakersfield area (Benson 1982). Pads may be dispersed by flood waters (ESA Planning and Environmental Services 1986*a*), but seed dispersal agents are unknown.

The total population of Bakersfield cactus was not estimated historically. Densely-spaced clumps of cactus once covered an estimated area of 6.5 by 0.8 kilometer (4 by 0.5 mile) from the Caliente Creek floodplain onto Sand Ridge (Twisselmann 1967). Historical photographs showing extensive stands of Bakersfield cactus (Britton and Rose 1920, Benson 1982) are believed to have been taken southwest of Sand Ridge near the eastern margin of the Kern Lake bed (R. van de Hoek pers. comm.). When the known sites were last inventoried, fewer than 20,000 clumps of Bakersfield cactus were estimated to remain. Only 4 areas had populations of 1,000 clumps or more: Comanche Point, Kern Bluff, north of Wheeler Ridge, and Sand Ridge (CDFG 1995, Moe 1989, R. van de Hoek pers. comm.). The metapopulations reported to incorporate the greatest morphological diversity included those in the Bena and Caliente Hills, Kern Canyon, and Sand Ridge (ESA Planning and Environmental Services 1986*a*, Bowen in litt. 1987, Moe 1989).

Habitat and Community Associations.—Soils supporting Bakersfield cactus typically are sandy, although gravel, cobbles, or boulders also may be present. Known populations occur on flood plains, ridges, bluffs, and rolling hills (CDFG 1995, ESA Planning and Environmental Services 1986*a*). Bakersfield cactus is a characteristic species of the Sierra-Tehachapi Saltbush Scrub plant community (Holland 1986, Griggs et al. 1992), but populations near Caliente are in Blue Oak Woodland and the Cottonwood Creek population is in riparian woodland (CDFG 1995, ESA Planning and Environmental Services 1986*a*, R. van de Hoek pers. comm.). Many Bakersfield cactus sites support a dense growth of red brome and other annual grasses (Cypher 1994*a*). Sand Ridge is characterized by sparse vegetation (ESA Planning and Environmental Services 1986*a*, Cypher 1994*a*) and a preponderance of native species such as California filago (*Filago californica*) and yellow pincushion (*Chaenactis glabriuscula*). Historical records indicate that the majority of Bakersfield cactus occurred at elevations ranging from 140 to 260 meters (460 to 850 feet). The highest-elevation population is at 550 meters (1,800 feet) near Caliente and the lowest remaining is at 121 meters (396 feet) at Fuller Acres (CDFG 1995).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—The primary reason for the decline of Bakersfield cactus was habitat loss. The formerly extensive tracts of Bakersfield cactus near Edison and Lamont were destroyed by conversion to row crops and citrus groves (Twisselmann 1967); much of the conversion occurred prior to 1931 (Benson 1982). Residential development eliminated numerous occurrences in northeast Bakersfield between Mount Vernon Avenue and Morning Drive in recent years (CDFG 1995). Petroleum production has contributed to habitat loss and fragmentation, particularly in the vicinity of Oildale. Populations near Hart Park, the Kern Bluffs, Oildale, Fairfax Road, and parts of Sand Ridge have been degraded by off-road vehicle activity, trash dumping, and sand and gravel mining. Overgrazing may have damaged plants near Hart Park, Mettler, and Caliente, and flooding decimated populations along Caliente Creek and the Kern River (CDFG 1995, Nelson 1983, Bowen in litt. 1987, Mitchell 1988, Moe 1989, R. van de Hoek pers. comm.). Air pollution is suspected to have contributed to the decline of Bakersfield cactus (Messick 1987).

Threats to Survival.—All the causes of decline continue to threaten existing populations of Bakersfield cactus. Almost all the known sites are on private land, much of which has commercial value. Residential development constitutes the most serious threat currently, especially in the greater Fairfax Road-Kern Bluff and Round Mountain Road areas. Conversion for either agricultural or residential use is possible near Wheeler Ridge. Inundation could be an intermittent problem for populations in floodplains and is a remote possibility for occurrences near the California Aqueduct; the largest concentration of clumps in the Wheeler Ridge metapopulation is situated adjacent to an overflow drain for the Aqueduct, which could lead to flooding if an earthquake occurred anywhere along its length (R. van de Hoek pers. comm.). Even the two protected populations (see Conservation Efforts) are adjacent to agricultural land and could be impacted by pesticide drift. Both off-road vehicle use and mining continue to degrade the populations mentioned earlier.

Direct competition from introduced, annual grasses is believed to threaten the survival of mature Bakersfield cactus plants and to hinder the establishment of new plants (ESA Planning and Environmental Services 1986*a*, Mitchell 1988). Indirect effects from exotic grasses also may threaten Bakersfield cactus in several ways. First, the dense herbaceous growth may promote a greater fire frequency and intensity than would have occurred with the sparse native vegetation typical in historical times. The effect of repeated fires has not been determined. However, survival of Bakersfield cactus plants was monitored following single fire events at Sand Ridge (Hewett in litt. 1987) and near the Rio Bravo Hydroelectric Plant in Kern Canyon (Lawrence 1987, George Lawrence and Associates 1988). All Bakersfield cactus clumps survived the fires at both sites, despite browning and wilting of the pads. During the following spring, cactus plants that were subject to low-intensity flames flowered, but those subject to moderate-intensity flames produced only vegetative growth. The affected cactus individuals near Rio Bravo were still alive 1 year following the fire, but no further observations were made of plants in either treatment area. Second, dense grass cover may harbor insects that damage cactus, which has been demonstrated with related species of *Opuntia* in Nebraska grasslands (Burger and Louda 1994). Third, the moist microclimate created by dense herbaceous growth may promote growth of decay organisms and cause pads to rot in years of above-average precipitation (E. Cypher unpubl. observ.).

A lack of genetic diversity may threaten some populations of Bakersfield cactus. Contributing factors to this problem include the small size of many populations (Moe 1989), a lack of gene flow between populations, and infrequent sexual reproduction (Messick 1987). Populations low in genetic variation are more vulnerable to diseases and parasites (Burdon and Marshall 1981) and to chance events, including environmental fluctuations, catastrophes, and genetic drift (Menges 1991).

5. Conservation Efforts

Bakersfield cactus was federally and state-listed as endangered in 1990 (USFWS 1990). The Nature Conservancy began preservation efforts for Bakersfield cactus over 25 years ago by purchasing a portion of Sand Ridge (Twisselmann 1969). Recently, The Nature Conservancy doubled the size of the Sand Ridge Nature Preserve, to 111 hectares (275 acres), by acquiring a remnant of the Caliente Creek wash at the eastern base of the ridge. The preserve was transferred to the Center for Natural Lands Management in 1998. Funding levels are insufficient to allow intensive monitoring or management trials, but prescribed burns will be used to control exotic grass competition (G. Hinshaw pers. comm.).

Several colonies of Bakersfield cactus have been acquired for conservation purposes within the past 2 years. The Implementation Trust for the Metropolitan Bakersfield Habitat Conservation Plan protected portions of three metapopulations by purchasing land in the Kern Bluff, Cottonwood Creek, and Oildale areas from willing sellers (R. Reed pers. comm.). The Wildlands Conservancy recently acquired the Pleito Hills population and plans to manage the area for the benefit of Bakersfield cactus and other sensitive species (D. Clendenen pers. comm.). Another portion of the Wheeler Ridge-Pleito Hills metapopulation is protected by the California Department of Water Resources, which has set aside 33 hectares (81 acres) adjacent to the California Aqueduct as a reserve for Bakersfield cactus through consultations with USFWS and CDFG. The only other site on public land is under the control of the Kern County Department of Parks and Recreation, where a few clumps occur adjacent to Hart Park. However, protection of Bakersfield cactus is neither the purpose nor a priority for the site (Moe 1989). Kern County is preparing a Habitat Conservation Plan, which likely will include provisions for protection of additional Bakersfield cactus populations through management agreements, conservation easements, and land acquisition (T. James pers. comm.). A Habitat Conservation Plan in preparation by California Department of Water Resources will address conservation of Bakersfield cactus and other species in the California Aqueduct right-of-way (K. Brown pers. comm.).

Salvage efforts have been undertaken by local members of the California Native Plant Society, who transplanted Bakersfield cactus clumps from sites slated for destruction to Sand Ridge Nature Preserve and the California Living Museum in Bakersfield. Prior to construction of the East Hills Mall in Bakersfield, a few of the cactus clumps growing on the site were removed, then were replanted in a display bed when the mall was completed. Transplanted individuals have not been monitored at any of the sites to determine survival rates or reproductive success (D. Mitchell pers. comm., R. van de Hoek pers. comm.).

6. Recovery Strategy

Due to social and economic considerations, Bakersfield cactus will never occur as widespread as it did historically. Instead, the recovery goal is to maintain self-sustaining populations in protected areas representative of the former geographic and topographic range of the taxon and in a variety of appropriate natural communities. The remaining populations occur in areas sufficiently representative of the former range to achieve this goal, but very little additional loss can be accommodated without compromising the long-term existence of the taxon. Thus, habitat protection is an important action to prevent the extinction or irreversible decline of Bakersfield cactus. Unoccupied habitat within metapopulations also should be protected to facilitate movement of pollinators and seed dispersers. An additional element of the strategy is to avoid fragmenting the few large metapopulations that remain (i.e., Caliente Creek, Comanche Point, Kern Bluff, Sand Ridge, and Wheeler Ridge) into more than two blocks of contiguous, protected natural land each. Land in the other target areas should be protected in blocks of at least 16 hectares (40 acres), and preferably in blocks of 65 hectares (160 acres) or more. The block size is smaller for Bakersfield cactus than for other listed plant species not for biological reasons, but because many of the areas already are so fragmented by development that larger blocks do not exist. Buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion. Surveys will be necessary to determine the size of natural populations in several of the target areas and the amount of existing occupied habitat. Transplantation of Bakersfield cactus is not a viable substitute for on-site protection. However, where development would destroy entire populations, as many of the clumps as possible should be transplanted to protected areas to salvage potentially unique genetic material, and the transplants should be monitored periodically to determine survival rates and reproductive success.

Demographic studies and matrix projection modeling will be necessary to identify vulnerable stages in the life cycle. Research then will be necessary to determine how to overcome factors that are identified as limiting to population growth. Because demographic research will take several years to complete and exotic plant competition seems to be detrimental to cactus in several ways, preliminary studies should begin immediately to test the hypothesis that exotic plants are contributing to mortality of Bakersfield cactus. A biosystematic study would determine whether Bakersfield cactus should be recognized as a full species.

G. Arid Grassland and Shrubland Plants

1. Lesser Saltscale
(Atriplex minuscula)

Taxonomy.—Lesser saltscale is a member of the goosefoot family (Chenopodiaceae). Standley published the name *Atriplex minuscula* in 1916. The name was not widely accepted, and for many years lesser saltscale was considered to be merely a variant of Parish's brittlescale (*A. parishii*) that did not warrant recognition (Abrams 1944, Munz and Keck 1959). However, Taylor and Wilken (1993) considered lesser saltscale to be a valid species and have returned to using the name *A. minuscula*.

Description.—Lesser saltscale has many upright, reddish stems up to 40 centimeters (16 inches) tall. The leaves are egg-shaped with *entire* (untoothed) margins and typically are opposite on the upper branches and alternate on the lower part of the stem. The individual flowers of all *Atriplex* species are inconspicuous because they are tiny and have no petals; moreover, the male and female structures are produced in separate flowers. In lesser saltscale, both flower genders occur in the *leaf axils* (the points where leaves are attached to the stem), with the male flowers on the upper part of the stem and the females near the base of the same plant (Munz and Keck 1959). Each fruit consists of a single reddish seed that is enclosed by two egg- to diamond-shaped bracts, which are covered with *tubercles* (wart-like projections). The closely-related species brittlescale (*Atriplex depressa*) and Parish's brittlescale have stems and branches that lie close to the ground, unlike the erect stems of lesser saltscale, and differ in *bract* characters (Taylor and Wilken 1993).

Historical Distribution.—Herbarium specimens of lesser saltscale were collected historically only at Goshen (Tulare County) in 1905 and El Nido (Merced County) in 1936 (CDFG 1995).

Current Distribution.—Neither of the historical sites has been checked to determine if lesser saltscale remains extant, though no significant patch of natural land exists in either area. In 1993, lesser saltscale was discovered at five new localities in the San Joaquin and Sacramento Valleys (Figure 17). The southernmost report was from Kern County, near the intersection of Interstate 5 and state Highway 58, and the northernmost was at Gray

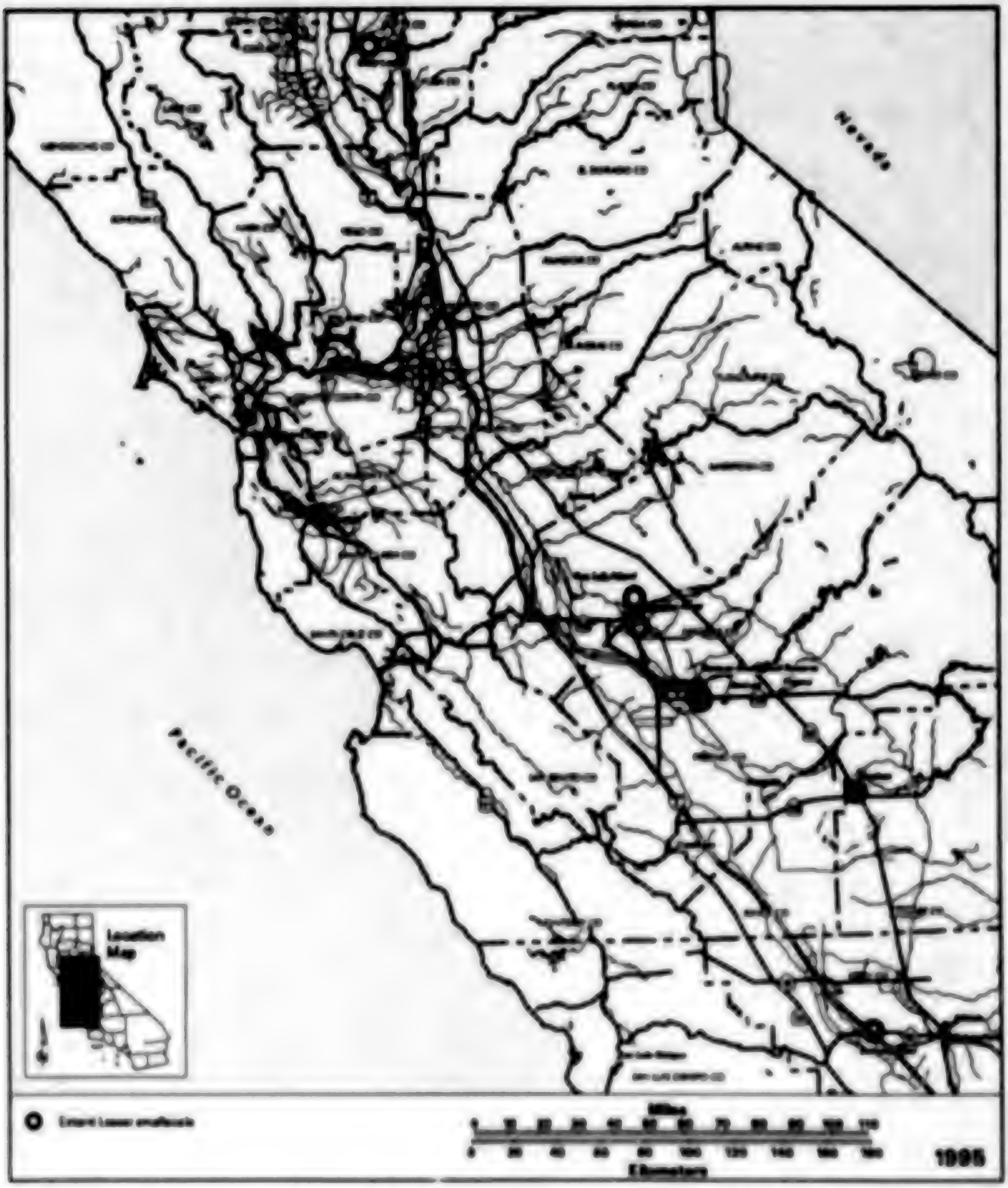

Figure 17. Distribution of lesser saltscale (*Atriplex minuscula*).

Lodge Wildlife Area in Butte County (CDFG 1995). Lesser saltscale also was reported from the Kerman Ecological Reserve in Fresno County (CDFG 1995), Arena Plains National Wildlife Refuge in Merced County (Silveira 1996), and along the Fresno River in Madera County (D. Mitchell pers. comm.).

Life History and Habitat.—The life history of lesser saltscale is poorly known, except that it is an annual and flowers from May to October (Skinner and Pavlik 1994). Lesser saltscale grows on sandy soils in alkaline areas at elevations of less than 100 meters (330 feet), often in association with slough systems and river floodplains. However, it is found only in microhabitats that are not inundated year-round. The species has been found in the Valley Sink Scrub, Valley Sacaton Grassland, and Nonnative Grassland natural communities. Lesser saltscale grows with other halophytes, including alkali sacaton, brittlescale, heartscale (*Atriplex cordulata*), and seepweed (CDFG 1995, D. Mitchell pers. comm., D. Taylor pers. comm.).

Reasons for Decline and Threats to Survival.—The lack of historical information about lesser saltscale prohibits a determination of whether or not it has declined. However, the conversion of alkali sinks to agriculture undoubtedly has reduced potential habitats (Skinner and Pavlik 1994). The extant population in Kern County is on land that is zoned for commercial development and which is for sale (CDFG 1995). The Madera County site is threatened by installation of a pipeline (D. Mitchell pers. comm.). Sites on state Wildlife Management Areas are threatened by flooding for waterfowl management (D. Taylor pers. comm.).

Conservation Efforts.—Lesser saltscale has not been the target of conservation actions. However, it may have benefited indirectly from land acquisition for other species, such as the Tipton kangaroo rat. Lesser saltscale could occur on USBLM lands in alkali sink areas (USBLM 1993) or on CDFG's Buttonwillow Preserve, which is near the known Kern County site and which includes similar habitat.

Conservation Strategy.—To ensure the long-term conservation of lesser saltscale, the strategy is to protect at least five populations representing the full geographic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. The highest-priority tasks for lesser saltscale are to survey historical sites and suitable habitat and to protect extant populations from development and other threats. All remaining unconverted alkali sinks in the Central Valley should be surveyed, and threats to any populations that are found must be evaluated. Surveys for lesser saltscale can be conducted concurrently with those for other rare plants that occur in alkali sinks, particularly palmate-bracted bird's-beak. Landowner cooperation is necessary to ensure protection on private lands, and the cooperation of public agencies is crucial on lands under their control. Moreover, threats must be alleviated in protected areas to ensure the continued survival of the species, and monitoring will be required to verify that populations are remaining stable. Seeds should be salvaged from any populations that are scheduled to be destroyed by development. When surveys have been completed, or at a maximum within 5 years of recovery plan approval, the status of lesser saltscale should be reevaluated.

2. Bakersfield Smallscale
(*Atriplex tularensis*)

Taxonomy.—Bakersfield smallscale was named *Atriplex tularensis* by Coville in 1893 (Skinner and Pavlik 1994). The type specimen was collected 25 kilometers (15 miles) south of Bakersfield on the Tulare Plains of Kern County (Twisselmann 1967). In 1914, Jepson reduced Bakersfield smallscale to a variety of *A. cordulata*, but Hall and Clements regarded it as a full species in their 1923 publication. The scientific name *Obione tularensis* was published by Engler and Prantl in 1934 (Niehaus 1977) but was not widely accepted. Taylor and Wilken (1993) used the scientific name *Atriplex tularensis* for Bakersfield smallscale.

Description.—In many respects, this species is similar to lesser saltscale because both are annual members of the same genus. However, Bakersfield smallscale has stems up to 80 centimeters (30 inches) tall, has only a few stiff branches, and the leaves may be narrower in proportion to their length (Figure 18). In Bakersfield smallscale, both male and female flowers occur in leaf axils throughout the plant, and the fruits are enclosed in diamond-shaped bracts that are smooth on the surface but toothed on the margin. Bractscale (*A. serenana*) is a related species that overlaps in range with Bakersfield smallscale. However, unlike Bakersfield smallscale, bractscale has toothed leaf margins, the male flowers occur only at the branch tips, and the fruiting bracts are wedge-shaped or round (Munz and Keck 1959, Freas and Murphy 1988, Taylor and Wilken 1993).

Historical Distribution.—Bakersfield smallscale was restricted historically to a small area of south-central Kern County between Greenfield and Mettler (Twisselmann 1969, Skinner and Pavlik 1994, CDFG 1995, Niehaus 1977). Collection localities were Greenfield, Adobe Station, Adobe Road, and Highway 223 (CDFG 1995).

Current Distribution.—The only extant population believed to represent Bakersfield smallscale is at Gator Pond, which is a remnant of Kern Lake, and formerly part of the Kern Lake Preserve (Figure 19). However, Bakersfield smallscale specimens collected in the area historically differ in appearance from those now present at Gator Pond (D. Taylor pers. comm.).

Life History and Habitat.—Bakersfield smallscale is a summer annual, germinating from May to June and flowering from June to October (Freas and Murphy 1991, Skinner and Pavlik 1994). Surface soil moisture is required during the summer and fall months for seed germination and seedling survival (Freas and Murphy 1988, Bowen 1986). The population at Gator Pond declined from 721 plants in 1985 to 13 in 1987 and 0 in 1992 as a result of a prolonged drought (Tollefson 1992). Other aspects of the life history and reproductive biology are unknown.

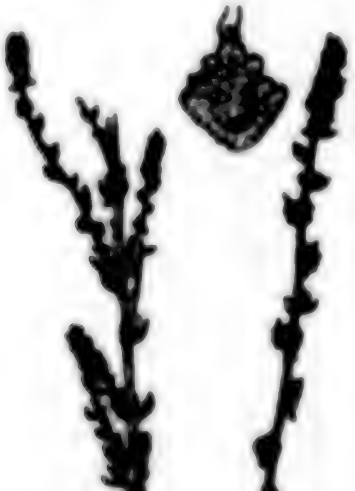

Figure 18. Illustration of Bakersfield smallscale (from Abrams Vol 2., 1944, with permission).

All the populations of Bakersfield smallscale were found on the subalkaline margins of alkali sinks at elevations of 91 to 96 meters (300 to 315 feet). Associated species included alkali heath, glasswort, scratchgrass (*Muhlenbergia asperifolia*), and saltgrass (Twisselmann 1969, CDFG 1995, Bowen 1986). Other species of concern that occur at Kern Lake are hispid bird's-beak and Buena Vista Lake shrew. Comanche Point layia occurred in the vicinity historically (CDFG 1995).

Reasons for Decline and Threats to Survival.—Like many of the other endangered plants of the San Joaquin Valley, the decline of Bakersfield smallscale was due primarily to agricultural activities (Skinner and Pavlik 1994, CDFG 1995). At most of the historical locations of Bakersfield smallscale, the habitat was completely destroyed by cultivation. At Gator Pond the soil surface was not disturbed, but the hydrology was altered by lowering the water table in the vicinity, leading to conditions too dry for germination and survival of Bakersfield smallscale in all but the wettest years (Bowen 1986, Tollefson 1992).

The *Atriplex* that now occurs at Gator Pond exhibits characteristics intermediate between Bakersfield smallscale and bractscale. Freas and Murphy (1988) speculated that under the drier conditions, bractscale increased and the two species hybridized. Thus, pure Bakersfield smallscale may be extinct. Even if the two species did not hybridize, the plants at Gator Pond may represent an undescribed form of bractscale (Skinner and Pavlik 1994, Skinner et al. 1995). Another possibility is that Bakersfield smallscale never was a distinct species, but instead was an environmental variant of bractscale that appeared only in years of high rainfall, when soil salinity decreased (Freas and Murphy 1988).

The greatest threat to the continued survival of the annual *Atriplex* at Gator Pond is conversion to agriculture. The landowner, J. G. Boswell Company, formerly leased the site to The Nature Conservancy as the Kern Lake Preserve, but the lease was not renewed in 1995 (R. Tollefson pers. comm.). Even if the J. G. Boswell Company chooses not to farm the land, the lack of sufficient water to the site threatens the continued existence of the plants.

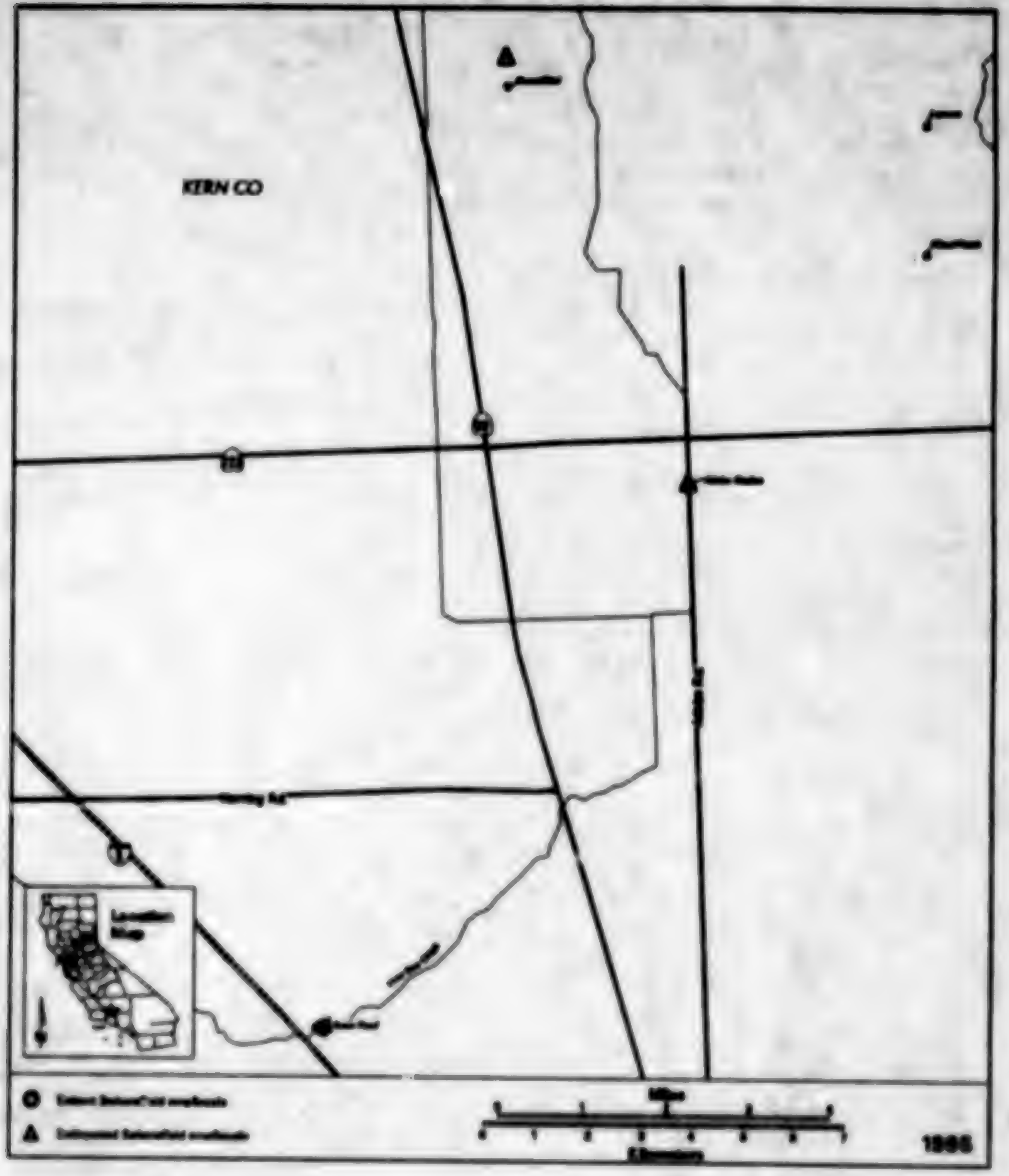
KERN CO
Location Map
Extant Bakersfield smallscale
Extirpated Bakersfield smallscale
Miles
Kilometers
1998

Figure 19. Distribution of Bakersfield smallscale (*Atriplex tularensis*).

Conservation Efforts.—Bakersfield smallscale was state-listed as endangered in 1987. During the period when The Nature Conservancy managed the Kern Lake Preserve, the Bakersfield smallscale population was monitored annually. When the population declined precipitously, The Nature Conservancy contracted Stanford University's Center for Conservation Biology to study the reasons for the decline. They began greenhouse propagation of plants in 1987, along with research on the site requirements and taxonomy of Bakersfield smallscale (Freas and Murphy 1988). Additional water was provided to the Gator Pond population in 1991. The potential for hydrologic restoration of the site is being studied (K. Freas pers. comm.), and USFWS is negotiating with the J.G. Boswell Company to protect the site (Medlin in litt. 1995*a*). The Kern County Valley Floor Habitat Conservation Plan is expected to provide incentives for protecting the Gator Pond area (T. James pers. comm.).

Conservation Strategy.—The conservation strategy for Bakersfield smallscale is similar to that for lesser saltscale: to protect at least 5 distinct populations numbering at least 1,000 individuals on natural land in blocks of at least 65 hectares (160 acres), with appropriate site management to ensure the continued existence of the species. To accomplish this goal, at least four additional populations must be discovered or established through artificial means, and the Gator Pond population must be increased substantially. Due to the precarious situation at the single known location, all recovery actions for Bakersfield smallscale are high priority. First, Gator Pond must be protected from conversion to other uses, either through a perpetual conservation easement or through transfer of fee title to a conservation entity. Hydrologic restoration of the site also is imperative. These actions also will further conservation of the Buena Vista Lake shrew. Surveys for Bakersfield smallscale should be conducted in the remaining alkali sink areas of Kern County, particularly in years with higher than normal precipitation. However, so little suitable habitat remains in the historic range of the species that four additional populations are not likely to be found during surveys.

Taxonomic studies and research into the effect of soil salinity on morphology (Freas and Murphy 1988) should continue. Also, genetic comparisons should be attempted between Gator Pond plants, bractscale, and related species to determine whether hybridization is possible (D. Taylor pers. comm.). Greenhouse propagation of the Gator Pond plants should continue, and seeds should be collected from any additional populations that are found. When definite Bakersfield smallscale populations are identified (at Gator Pond or elsewhere), introductions to protected alkali sinks in Kern County should begin immediately to bring the total number of sites to five. The status of Bakersfield smallscale should be reevaluated within 5 years of recovery plan approval.

3. Lost Hills Saltbush
(Atriplex vallicola)

Taxonomy.—Lost Hills saltbush has retained the scientific name *Atriplex vallicola* since Hoover (1938) first described it. However, according to Taylor and Wilken (1993) a more appropriate rank for Lost Hills saltbush may be as a subspecies of crownscale (*A. coronata*). Another common name for *A. vallicola* is Lost Hills crownscale (Taylor and Wilken 1993). The type locality for Lost Hills saltbush is 8 kilometers (5 miles) north of the Lost Hills oil field, in Kern County (Hoover 1938). Plants from the Carrizo Plain may represent an undescribed subspecies of *A. vallicola* (Taylor and Wilken 1993, Skinner and Pavlik 1994).

Description.—Lost Hills saltbush reaches a maximum height of only 20 centimeters (8 inches). The male and female flowers are mixed in small clusters in the upper leaf axils. The fruiting bracts are broadly triangular, irregularly toothed, and may or may not have tubercles. Lost Hills saltbush differs from crownscale primarily in the shape and size of the bracts (Hoover 1938, Taylor and Wilken 1993).

Historical Distribution.—Prior to 1980, Lost Hills saltbush was reported from three general areas: north of Lost Hills (CDFG 1995), Mendota in Fresno County (Hoover 1938), and the Carrizo Plain in San Luis Obispo County (Hoover 1970).

Current Distribution.—In the 1980s, a number of additional sites were discovered, and the species was confirmed to be extant near Lost Hills and on the Carrizo Plain (Figure 20). The centers of concentration currently known are: (1) Lost Hills to extreme southern Kings County; (2) the Kerman Ecological Reserve in Fresno County; (3) the Soda Lake region of the Carrizo Plain; (4) the Lokern- McKittrick area of Kern County; and (5) southwestern Merced County (Olson and Magney 1992,

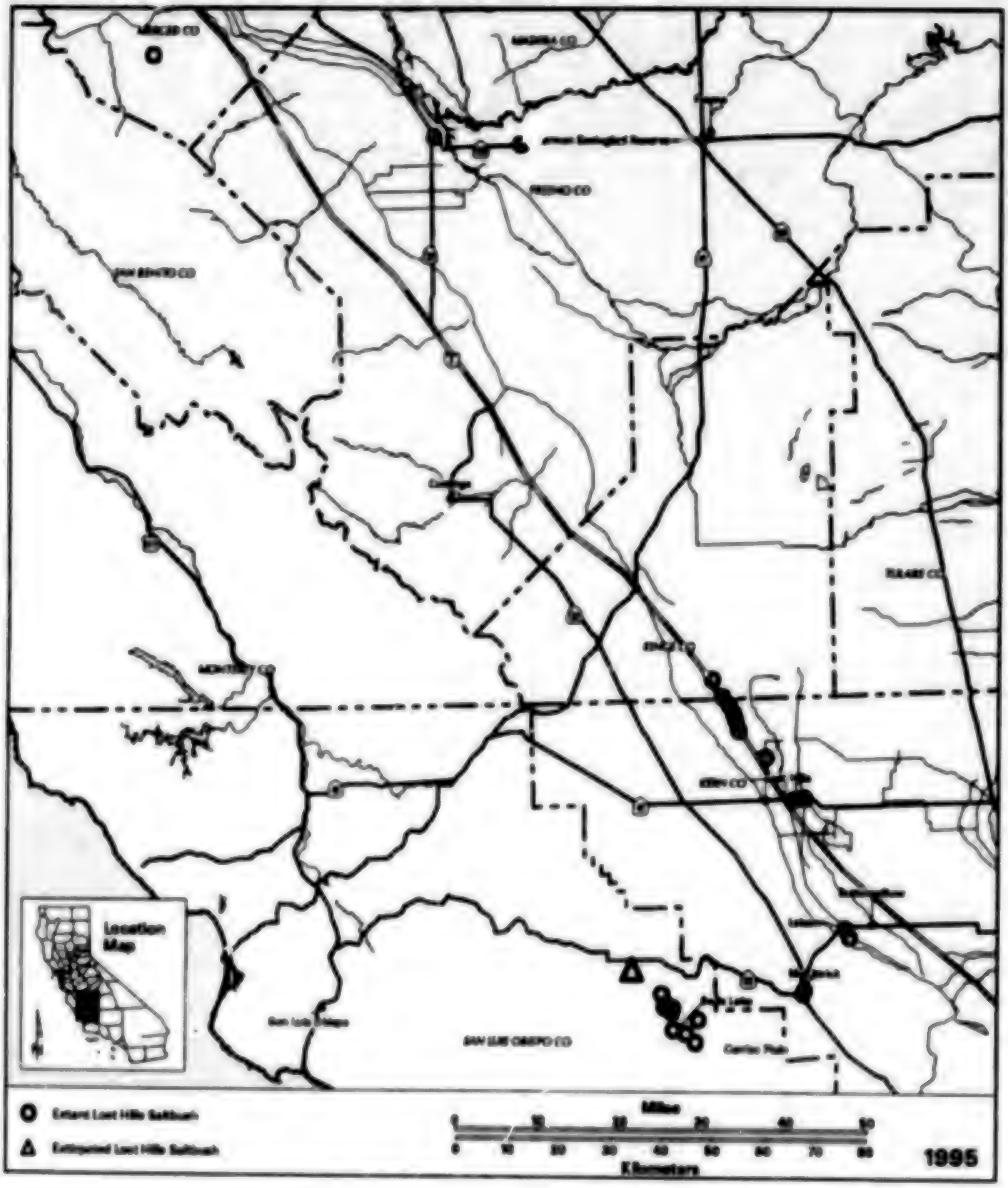

Figure 20. Distribution of Lost Hills saltbush (*Atriplex vallicola*).

Skinner and Pavlik 1994, CDFG 1995). The Lost Hills and Carrizo Plain centers of concentration represent large (greater than 10,000 plants) metapopulations, but most other sites had only a few hundred individuals or fewer in 1993 (CDFG 1995).

Life History and Habitat.—Lost Hills saltbush is an annual that flowers from May to August (Skinner and Pavlik 1994). Other aspects of its life history have not been studied. This species occurs in the Valley Sink Scrub, Valley Saltbush Scrub, Nonnative Grassland, and Alkali Meadow natural communities. At most sites, Lost Hills saltbush grows in the dried beds of alkaline pools, but one population south of McKittrick occurs on exposed slopes rich in gypsum. Associated species include common saltbush, spiny saltbush, alkali heath, saltgrass, and seepweed. Valley-floor populations occur at elevations of 50 to 85 meters (165 to 280 feet), whereas those on the Carrizo Plain and south of McKittrick range from approximately 400 to 600 meters (1,300 to 2,000 feet) in elevation (Hoover 1938, Olson and Magney 1992, CDFG 1995, California Native Plant Society 1988*a*).

Reasons for Decline and Threats to Survival.—Two occurrences of Lost Hills saltbush, one near Lost Hills and one on the Carrizo Plain, were eliminated by agricultural conversion. Trampling by livestock degraded habitat for this species at several sites. One of the largest occurrences (near Soda Lake) is on private land that has been partially cleared for a mobile home. Currently, the Lost Hills center of concentration is in the greatest danger of elimination; it is on private land in an area valuable for commercial development and agriculture. In addition, flooding for waterfowl management poses a threat in the vicinity of Lost Hills. The population south of McKittrick faces potential threats from petroleum production, off-road vehicle activity, and the installation and maintenance of an electric transmission line (Skinner and Pavlik 1994, CDFG 1995, California Native Plant Society 1988*c*).

Conservation Efforts.—Although Lost Hills saltbush has not been the subject of direct conservation efforts, it has benefited indirectly from acquisition directed at other species. Much of the land around Soda Lake has been purchased by USBLM as part of the Carrizo Plain Natural Area. Soda Lake is included in the Carrizo Plain Area of Critical Environmental Concern (USBLM 1993), and grazing is not allowed in that area currently (Doran in litt. 1993). One occurrence in Lokern now is on Center for Natural Lands Management land, and the Kerman Ecological Reserve is managed by CDFG. Additional lands in the Lost Hills and Lokern areas may be protected if the Kern County Valley Floor Habitat Conservation Plan is implemented as planned, but no specific measures are provided for the conservation of Lost Hills saltbush (T. James pers. comm.). Floristic surveys of Naval Petroleum Reserve-1 in California (now Occidental of Elk Hills) may reveal populations of Lost Hills saltbush in suitable habitats on the margins of Elk Hills (J. Hinshaw pers. comm.).

Conservation Strategy.—The most important task for conservation of Lost Hills saltbush is to protect existing populations on private land from ongoing threats. To do so, sites must be secured through conservation easements or acquisition, and public agencies must agree to protect habitat on lands under their control. Lost Hills saltbush can benefit from recovery actions directed at the listed plant and animal species, many of which occur in the same areas. Surveys must also be conducted in suitable habitat. Because it is inconspicuous and difficult to identify, Lost Hills saltbush may have been overlooked, even in areas already set aside for conservation purposes. If at least five distinct populations representing the full geographic range of the species are protected and managed to promote the continued survival of Lost Hills saltbush, long-term conservation should be ensured. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Taxonomic research should be done to determine the appropriate rank and affinities of Lost Hills saltbush, including the entity on the Carrizo Plain. When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Lost Hills saltbush should be reevaluated.

4. Vasek's Clarkia
(C. tembloriensis ssp. calientensis)

Taxonomy.—Vasek's clarkia, a member of the evening-primrose family (Onagraceae), was described originally as a full species, *Clarkia calientensis* (Vasek 1977). The type locality of Vasek's clarkia is ". . . along Caliente Road, 10 kilometers E of the junction with the Bakersfield-Tehachapi highway" (Vasek 1977, p. 252).

Based on its morphological similarity to the more common Temblor clarkia (*Clarkia tembloriensis*), Holsinger (1985) proposed the name *C. tembloriensis* ssp. *calientensis*, which is in current use (H. Lewis 1993). However, biosystematic studies in progress suggest that Vasek's clarkia is a unique taxon that originated independently of Temblor clarkia in recent times (T. Holtsford pers. comm.).

Description.—Vasek's clarkia can grow up to 80 centimeters (30 inches) tall and has alternate, grayish-green, lance-shaped leaves. The flowers have four lavender-pink petals with narrow bases and diamond-shaped tips. The *styles* (part of the female reproductive system) are approximately the same length as the stamens. Vasek's clarkia has broader petals, shorter styles, narrower fruits, and larger seeds than Temblor clarkia, and both differ from gunsight clarkia (*C. unguiculata*) in that they lack long hairs on the flower parts (Holsinger 1985, H. Lewis 1993).

Historical Distribution.—This taxon is endemic to the Caliente Hills of Kern County, which are southeast of Bakersfield (Skinner and Pavlik 1994). The historical distribution consisted of only the type locality, where the taxon was first collected in 1967 (Vasek 1977).

Current Distribution.—Plants have not been observed at the type locality since 1982, despite repeated searches. However, two other occurrences were discovered west of the type locality in 1982 (Figure 21); they represent a single metapopulation (CDFG 1995, T. Holtsford pers. comm.).

Life History and Habitat.—Vasek's clarkia is an annual, flowers in April (Skinner and Pavlik 1994), and is self-pollinating. The timing of seed germination in the wild is not known, but in greenhouse tests, plants that were started from seed in January had a higher reproductive output than those that were started in November (Vasek 1977). The closely-related Springville clarkia (*Clarkia springvillensis*) forms a persistent seed bank, and this taxon may as well (T. Holtsford pers. comm.). Vasek's clarkia grows in steep-sided canyons on grassy north- and west-facing slopes at elevations of 275 to 335 meters (900 to 1,100 feet). Associated species include bladderpod, farewell-to-spring (*Clarkia cylindrica*), and gunsight clarkia (CDFG 1995). The extant metapopulation comprises several thousand individuals in favorable years but has extremely low genetic variability (T. Holtsford pers. comm.).

Reasons for Decline.—The reason for the disappearance of Vasek's clarkia from the type locality is unknown. The other two occurrences have not declined.

Threats to Survival.—Vasek's clarkia is a very narrow endemic because of its extremely limited range, small population size, and lack of genetic variability. Thus, Vasek's clarkia is very vulnerable to extinction from random catastrophic events. All three of the reported occurrences were on private property, some of which is owned by the Tejon Ranch Company. Most of the occupied habitat is too steep to be developed or heavily grazed (T. Holtsford pers. comm.). Competition from exotic grasses is believed to be the primary threat to this taxon (T. Holtsford pers. comm.).

Conservation Efforts.—Vasek and his colleagues have conducted taxonomic and genetic research, surveyed limited areas in the Caliente Hills, and monitored Vasek's clarkia since the species was first described. However, access to the sites has been restricted by the land owner in recent years (CDFG 1995, T. Holtsford pers. comm.). No other conservation measures have been instituted to date, but Kern County may provide incentives for conservation of the populations through the Valley Floor Habitat Conservation Plan (T. James pers. comm.).

Conservation Strategy.—Although Vasek's clarkia is a narrow endemic, at least five separate populations should be protected to increase the probability of long-term survival. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Conservation of Vasek's clarkia entails maintaining compatible uses at the known sites, controlling exotic grasses, surveying suitable habitats for additional populations, and banking seed as a safeguard against extinction. Conservation agreements with the private landowners are recommended, even though development is not expected in the area in the near future. Holtsford (pers. comm.) recommends continued light grazing to control grasses. Monitoring will be important to evaluate population trends; changes in site management may be necessary if declining population trends are observed. Surveys for Vasek's clarkia could be coordinated with those for California jewelflower and Bakersfield cactus, which occurred historically in the Caliente Hills, and where potential habitat still exists. Seed collections would not need to be large to be

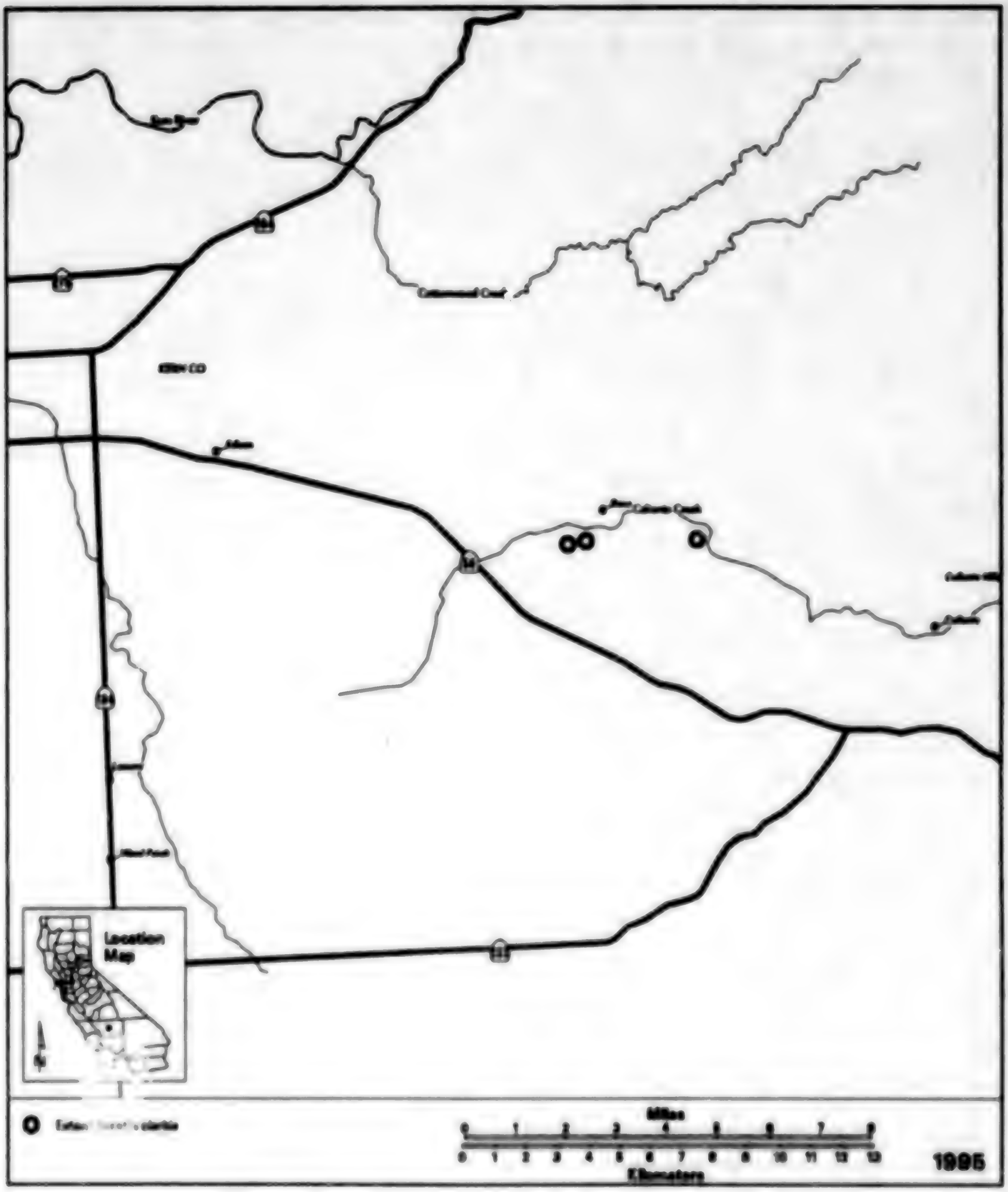

Figure 21. Distribution of Vasek's clarkia *(C. tembloriensis ssp. calientensis).*

representative of the gene pool in the extant metapopulation but should be conducted according to Center for Plant Conservation (1991) recommendations. Introduction of the subspecies outside of the known range is not recommended, but planting of seeds in nearby suitable habitats within the historic range may be necessary to achieve the required number of populations if surveys prove unsuccessful. The status of Vasek's clarkia should be reevaluated within 5 years of recovery plan approval.

5. Temblor Buckwheat
(Eriogonum temblorense)

Taxonomy.—Temblor buckwheat was named *Eriogonum temblorense* by Howell and Twisselmann (1963) and is a member of the buckwheat family (Polygonaceae). The type specimen was collected by Twisselmann in Chico Martinez Canyon, in Kern County. The scientific name has remained unchanged since it was published, but various authors (Hoover 1970, Reveal 1989, Hickman 1993, Skinner and Pavlik 1994, Skinner et al. 1995) have speculated that Temblor buckwheat should be combined with Eastwood's buckwheat (*E. eastwoodianum*).

Description.—The height of Temblor buckwheat ranges from 10 to 80 centimeters (4 to 30 inches) and varies with precipitation. The leaves occur primarily at the base of the plant and are densely covered with matted hairs on both surfaces. The appearance of individual plants of Temblor buckwheat may vary from spring to fall, with the blades rounded early in the year and more elliptical later (Hoover 1970). The branches, which are elongated and spreading, bear flowers only at their tips, where several 2-millimeter (0.08-inch) long, white flowers are clustered inside a cup-like structure. Temblor buckwheat is differentiated from Eastwood's buckwheat and another closely related species, Idria buckwheat (*E. vestitum*), by the placement of the leaves and the size and surface texture of certain flower parts (Reveal 1989, Hickman 1993). However, the spring form of Temblor buckwheat closely resembles Eastwood's buckwheat (Hoover 1970).

Historical Distribution.—The range of Temblor buckwheat apparently always has been restricted. The historical distribution is based on 19 collections, which are clustered in eight areas of the inner Coast Ranges: Chico Martinez Canyon and the Shale Hills in Kern County; Indian Valley, Parkfield Grade, and Stone Canyon in Monterey County; and Polonio Pass, Cottonwood Pass, and the Shandon area in San Luis Obispo County (Twisselmann 1967, Hoover 1970, CDFG 1995).

Current Distribution.—The historical occurrences have not been revisited in recent years but are believed to be extant (Skinner and Pavlik 1994). Another center of occurrence was discovered on the Elkhorn Plain in 1995 (Figure 22).

Life History and Habitat.—Temblor buckwheat is an annual, but it differs from most annuals of the San Joaquin Valley in that it flowers during the hottest part of the year, from May through September (Twisselmann 1967, Reveal 1989, Skinner and Pavlik 1994). Other aspects of its life history have not been investigated. Temblor buckwheat typically occurs on white, shattered shale (Twisselmann 1967, R. Lewis pers. comm.) and occasionally on sandstone (Hickman 1993). The shale areas are dry and nearly barren of other vegetation, but California buckwheat (*Eriogonum fasciculatum*), sun cups (*Camissonia californica*), and Booth's evening-primrose (*C. boothii*) may be present (Lewis in litt. 1995, D. Taylor pers. comm.). The type locality was characterized by saltbush scrub (CDFG unprocessed data). All reported sites for Temblor buckwheat are below 1,000 meters (3,300 feet) in elevation (Hickman 1993). The Elkhorn Plain metapopulation occurs on slopes of 0 to 25 percent (Lewis in litt. 1995).

Reasons for Decline and Threats to Survival.—The current status of Temblor buckwheat is unknown because threats have not been evaluated at the historical locations. The Elkhorn Plain metapopulation occurs on USBLM land that is protected as an Area of Critical Environmental Concern (USBLM 1996*a,b*). Only one minor threat was noted by Lewis on the Elkhorn Plain (in litt. 1995): some plants were trampled by cattle in the vicinity of a water trough. The other historical localities are on private property in areas that currently are not desirable for development.

Conservation Efforts.—Russ Lewis (pers. comm.) of USBLM conducted surveys for Temblor buckwheat in potential habitats of the southern Caliente Range, southern Temblor Range (south of Crocker Grade), and the Maricopa area in 1995. He found the species only on the Elkhorn Plain. Temblor buckwheat possibly could

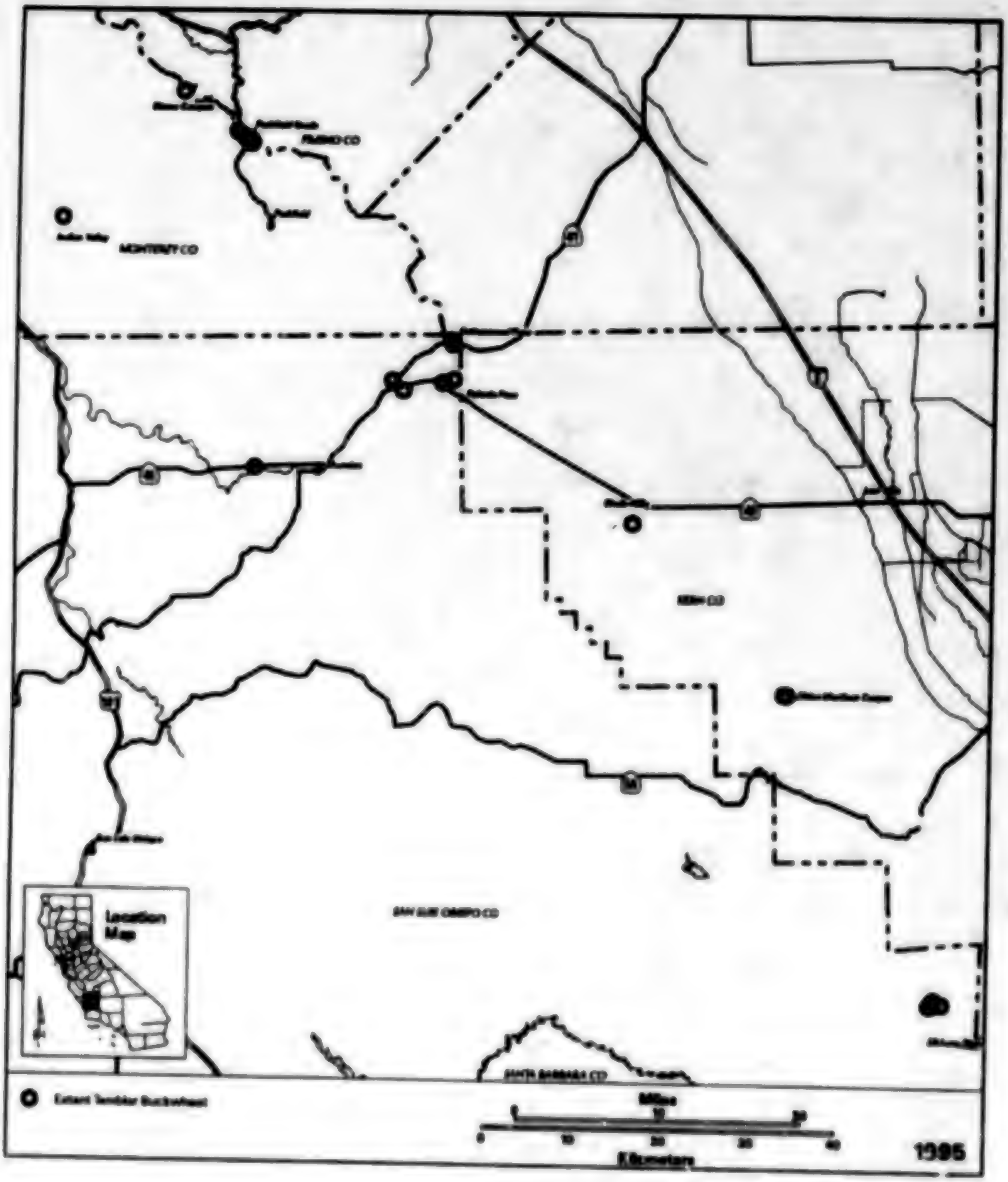

Figure 22. Distribution of Temblor buckwheat (*Eriogonum temblorense*).

occur on USBLM's proposed Chico Martinez Area of Critical Environmental Concern (USBLM 1996*a*,*b*), but surveys would be necessary to verify the presence of the species there.

Conservation Strategy.—To ensure the long-term conservation of Temblor buckwheat, the strategy is to protect at least five populations representing the full geographic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Historical locations of Temblor buckwheat should be surveyed to verify whether the species still persists, to evaluate threats, and to obtain population estimates. Periodic monitoring of the populations is recommended, particularly on the Elkhorn Plain due to the potential impacts of cattle trampling. Current management should be continued in all areas where the species is found; if the populations decrease in favorable years, changes in management may be necessary. Biosystematic studies would be valuable to establish the relationship of plants in this complex (Skinner et al. 1995), but this task is of low priority. When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Temblor buckwheat should be reevaluated.

6. Tejon Poppy
(Eschscholzia lemmonii ssp. *kernensis)*

Taxonomy.—Both this taxon and the next are members of the poppy family (Papaveraceae). Tejon poppy was initially given the name *Eschscholzia caespitosa* ssp. *kernensis* based on a specimen from the "Tejon Hills, 2 miles northwest of Tejon Ranch headquarters, Kern County" (Munz 1958, p. 91). However, Tejon poppy has more characters in common with Lemmon's poppy (*Eschscholzia lemmonii* ssp. *lemmonii*) than with tufted poppy (*Eschscholzia caespitosa*), and thus Clark (1986) renamed Tejon poppy *E. lemmonii* ssp. *kernensis*.

Description.—Tejon poppy reaches a maximum height of 30 centimeters (12 inches). The deeply-divided leaves are mostly clustered at the base of the plant (Figure 23). Each flowering stem is taller than the leaves and bears a single erect, hairless bud that develops into a showy, orange flower. Tejon poppy lacks a rim-like appendage below the flower. The fruit is elongated and contains many tiny, rough seeds. Unlike Tejon poppy, Lemmon's poppy has nodding, hairy buds and California poppy (*E. californica*) has a conspicuous, flared rim beneath the flower. Tufted poppy has smaller, yellow flowers and smoother seeds (Munz and Keck 1959, Clark 1986, 1993).

Historical Distribution.—Tejon poppy is restricted to Kern County. Based on literature reports and collections, the taxon occurred historically in six areas in the low hills that surround the southern tip of the San Joaquin Valley (Figure 24). Twisselmann (1967) noted that in the Tejon Hills, this taxon occurred between Chanac and Tejon Canyons. Other historical locations were Dry Bog Knoll in Adobe Canyon (between Bakersfield and Woody), "mesas east of Bakersfield" (Twisselmann 1967, p. 240), Comanche Point (Twisselmann 1969), Elk Hills, Pleito Hills (CDFG 1995), and near Maricopa (Skinner and Pavlik 1994).

Current Distribution.—Tejon poppy is known to remain extant at Elk Hills (Enterprise Advisory Services, Inc. in litt. 1998). The other historical populations may be extant but have not been revisited in 3 or more decades.

Life History and Habitat.—This annual herb flowers from March to April (Skinner and Pavlik 1994). Details of the life history are not known, but Tejon poppy populations are conspicuous only in years of above-

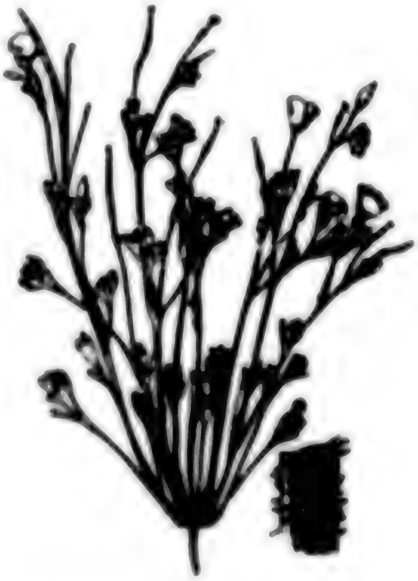

Figure 23. Illustration of Tejon poppy (from Abrams, Vol. 2, 1944, with permission).

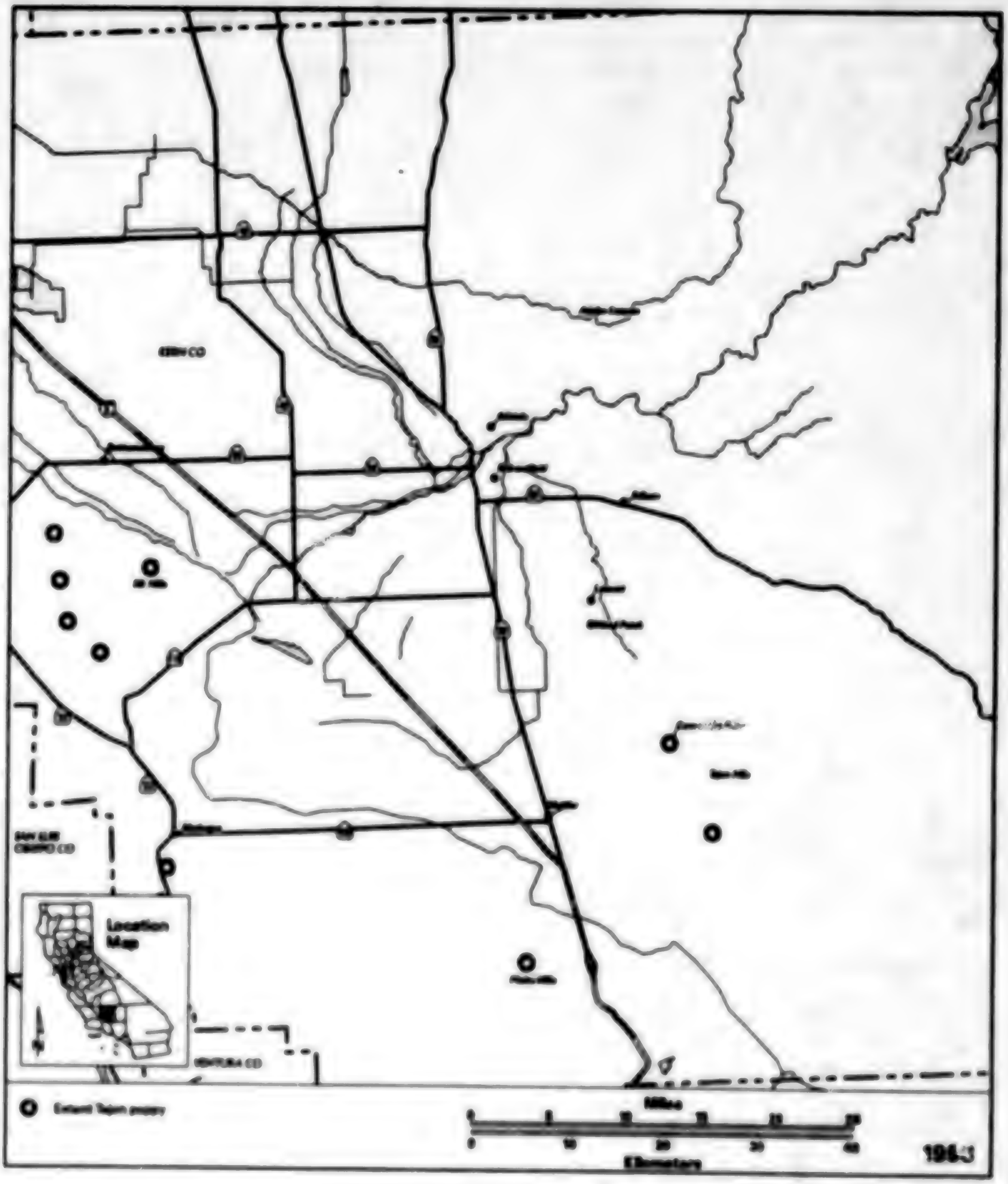

Figure 24. Distribution of Tejon poppy (*Eschscholzia lemmonii* ssp. *kernensis*).

average precipitation (Twisselmann 1967). Tejon poppy grows on adobe clay soils in sparsely-vegetated grasslands between 250 and 600 meters (800 and 2,000 feet) in elevation (Munz and Keck 1959, Twisselmann 1967, 1969, CDFG 1995). At Comanche Point, Tejon poppy was observed in association with Kern brodiaea (*Brodiaea terrestris* ssp. *kernensis*), Sunset lupine (*Lupinus microcarpus* var. *horizontalis*), and Comanche Point layia (Twisselmann 1969).

Reasons for Decline.—Tejon poppy has always been rare by virtue of its restricted range and soil affinities. Twisselmann (1967, p. 240) described it as "normally scarce." Except for Elk Hills, all the areas in which it occurred are on private land, but none have been subject to urban or industrial development.

Threats to Survival.—Potential threats to Tejon poppy include competition from exotic plants, overgrazing (Skinner and Pavlik 1994), and future residential development.

Conservation Efforts.—This taxon has not been the focus of conservation measures, nor have any of the historical areas of occurrence been protected for other rare species. However, the U.S. Department of Energy sponsored floristic surveys that led to the discovery of four colonies of Tejon poppy at Elk Hills in 1997 (Enterprise Advisory Services, Inc. 1998). Occidental Petroleum is continuing the floristic surveys at Elk Hills, which may reveal additional populations in the area (J. Hinshaw pers. comm.).

Conservation Strategy.—To ensure the long-term conservation of Tejon poppy, the strategy is to protect at least five populations representing the full geographic range of the taxon. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Historical locations for Tejon poppy must be searched to determine if the subspecies is extant and what site-specific threats it may face. Any extant populations should be protected from identified threats. If Tejon poppy remains extant at Comanche Point, it could be protected in conjunction with Bakersfield cactus and Comanche Point layia. Monitoring is necessary to determine whether the populations are self-sustaining. When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Tejon poppy should be reevaluated.

7. Diamond-petaled California Poppy
(Eschscholzia rhombipetala)

Taxonomy.—The scientific name of this species, *Eschscholzia rhombipetala*, was published by Greene in 1885 (Abrams 1923). Jepson later reduced it to a subspecies of tufted poppy, assigning the name *E. caespitosa* var. *rhombipetala* (Munz and Keck 1959). Currently, the name *E. rhombipetala* is in use (Clark 1993).

Description.—Diamond-petaled California poppy resembles Tejon poppy and Lemmon's poppy in many respects. However, diamond-petaled California poppy may have erect or nodding buds, the flowers are small and yellow, and the bases of the leaves are fleshy (Hoover 1970, Clark 1993, Clark in litt. 1979). The fruits of diamond-petaled California poppy are conspicuous because they are 4 to 7 centimeters (1.5 to 3 inches) long, which may nearly equal the height of the plants (Hoover 1970). Diamond-petaled California poppy is distinguished from frying pans (*E. lobbii*), another poppy that occurs in the same general area, by leaf position and seed characteristics (Clark 1993).

Historical Distribution.—Diamond-petaled California poppy was known historically from seven sites in the inner Coast Ranges (Figure 25): Corral Hollow in Alameda County; Antelope Valley near the town of Sites in Colusa County; Antioch and the hills south of Byron in Contra Costa County; the La Panza area and near Yeguas Creek in San Luis Obispo County; and Del Puerto Canyon in Stanislaus County (Hoover 1970, Clark 1993, CDFG 1995, Clark in litt. 1979, Bittman 1986*b*). Hoover (1970) mentioned that the species occurred in San Joaquin County, but no specimens remain to document his report (Skinner and Pavlik 1994).

Current Distribution.—At least two extant populations of diamond-petaled California poppy are known. The first discovered in 1992; it was on a privately-owned portion of the northern Carrizo Plain in San Luis Obispo County. Although diamond-petaled California poppy was not present on the same site in 1995, it may reappear in favorable years. The second confirmed population is on Lawrence Livermore National Laboratory property in Alameda County, where it was discovered in 1997. It is believed to be the occurrence reported historically as Corral Hollow. Diamond-petaled California poppy may have been

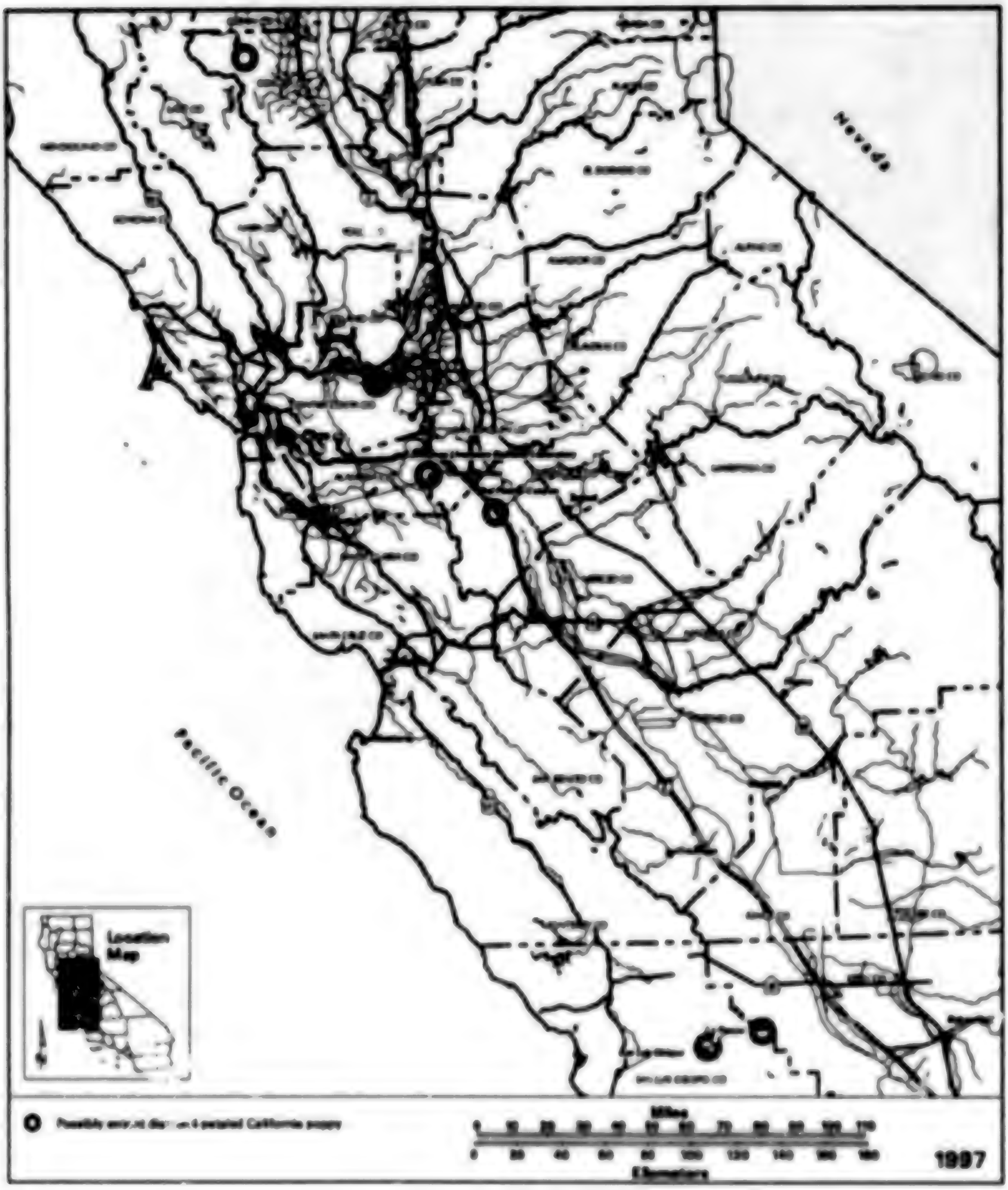

Figure 25. Distribution of diamond-petaled California poppy (*Eschscholzia rhombipetala*)

rediscovered at La Panza, but the identification is questionable. Another reported occurrence in San Luis Obispo County is sketchy (California Natural Diversity Data Base 1997). The other historical populations have not been observed since 1950 (Skinner and Pavlik 1994, Skinner et al. 1995).

Life History and Habitat.—The ecology of diamond-petaled California poppy has not been studied in detail. Flowering specimens were collected from March into early May. Conditions for germination, pollinators, seed dispersers, and demography are unknown. Most of the populations reported have been on hillsides, but community associations varied widely among the sites that have been described in detail. The Carrizo Plain site was open saltbush scrub interspersed with vernal pools; soil type was not reported. Associated species included spiny saltbush, several species of goldfields (*Lasthenia* species), Munz's tidy-tips, red brome, and other annuals (California Natural Diversity Data Base in litt. 1997). At Lawrence Livermore National Laboratory, diamond-petaled California poppy occurred on clay where an eroding bank merged with annual grassland. Other plants in the vicinity were the forbs wind poppy (*Stylomecon heterophylla*) and microseris (*Microseris douglasii*) and the grasses pine bluegrass (*Poa secunda*), slender wild oats (*Avena barbata*), and red brome (California Natural Diversity Data Base in litt. 1997). Near La Panza, diamond-petaled California poppy was found on nearly barren areas of clay soils in association with San Benito thornmint (*Acanthomintha obovata*) and large-leaved filaree (*Erodium macrophyllum*) (Hoover 1970, Bittman 1986*b*). Clark (1993) indicated that diamond-petaled California poppy had been found in fallow fields. The historical sites were found at 9 to 1,000 meters (30 to 3,300 feet) in elevation (California Natural Diversity Data Base in litt. 1997).

Reasons for Decline and Threats to Survival.— The reasons why diamond-petaled California poppy has not been seen at many historical localities are unknown. Natural land remains in most of the areas where it was collected historically, although some land in the vicinity of Yeguas Creek has been converted to agriculture and the La Panza area is subject to heavy grazing (CDFG 1995, Bittman 1986*b*). The Antioch area is growing rapidly and thus is subject to development pressure. Threats to extant populations are agricultural conversion on the northern Carrizo Plain and erosion at Lawrence Livermore National Laboratory.

Conservation Efforts.—Concentrated surveys near historical locations led to the discovery of the Carrizo Plain and Livermore Laboratory populations. Searches in the La Panza area in 1991 revealed only Lemmon's poppy (CDFG 1995). The diamond-petaled California poppy at Lawrence Livermore National Laboratory is being protected from disturbance by the Department of Energy (T. Kato pers. comm.).

Conservation Strategy.—The conservation strategy for diamond-petaled California poppy is to protect the Lawrence Livermore Laboratory population and at least four other populations representing the full historic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Considering that suitable habitat remains at many of the historical sites, efforts to rediscover diamond-petaled California poppy should continue, particularly in years of above-average rainfall. Any other sites determined to have the appropriate community associations should also be surveyed. Possible sites include East Bay Regional Parks' Black Diamond Mine, Los Vaqueros Watershed, and the Altamont Creek Watershed. If additional populations are discovered during surveys, threats must be determined on a site-by-site basis. Changes in site uses are not necessary unless impacts to the population are noted. Monitoring should be initiated as soon as occurrences are found. If additional populations are found but fewer than five populations can be protected, seed collection (Center for Plant Conservation 1991) and introduction to public lands will be necessary to ensure the continued existence of the species. The status of diamond-petaled California poppy should be reevaluated within 5 years of recovery plan approval or when surveys have been completed, whichever is less.

8. Comanche Point Layia
(Layia leucopappa)

Taxonomy.—Keck (1935) gave Comanche Point layia the name *Layia leucopappa*. The common name refers to the type locality in Kern County, where this species was first collected in 1927. The original scientific name is still in use (Baldwin and Bainbridge 1993). Comanche Point layia is a member of the aster family.

Description.—Comanche Point layia (Figure 26) has glandular stems that grow up to 60 centimeters (24 inches) tall. The leaves are oblong, fleshy, and entire to lobed. Each daisy-like flower head is composed of two kinds of tiny flowers: *ray florets* have flattened corollas and occur near the margin of the head, whereas *disk florets* are tubular and are clustered in the center of the head. Comanche Point layia has 6 to 15 white ray florets and 20 to 100 yellow disk florets. The achenes produced by the ray and disk florets differ slightly. Comanche Point layia is distinguished from other members of the genus that have white ray flowers by the fleshy leaves and microscopic characters of the flower head and achenes (Munz and Keck 1959, Abrams and Ferris 1960, Baldwin and Bainbridge 1993).

Historical Distribution.—Comanche Point layia is endemic to Kern County. It occurred historically in three general areas of the extreme southern San Joaquin Valley and adjacent hills to the east (Figure 27): (1) the Comanche and Tejon Hills (including the type locality), (2) between Edison and Bena, and (3) on the Valley floor near the southern end of Kern Lake (Twisselmann 1967, 1969, CDFG 1995).

Current Distribution.—Comanche Point layia remains in the Comanche and Tejon Hills but has not been observed in the Edison-Bena area or on the Valley floor since 1935 (CDFG 1995).

Life History and Habitat.—The typical flowering period for Comanche Point layia, an annual, is March to April (Munz and Keck 1959). However, it has been observed only in years of higher than average rainfall (Twisselmann 1967, 1969). Cross-pollination is necessary for seed set (Munz and Keck 1959). In the Comanche and Tejon Hills, Comanche Point layia grows on sparsely-vegetated microhabitats in Nonnative Grassland. Associated species include annual buckwheats (*Eriogonum* spp.), hollisteria (*Hollisteria lanata*), leafy-stemmed coreopsis (*Coreopsis calliopsidea*), and Tejon poppy. On the Valley floor, Comanche Point layia was found on the margins of alkali sinks and on hummocks. Comanche Point layia typically occurs on light-colored, subalkaline clay soils at elevations of 150 to 350 meters (500 to 1,150 feet) (Twisselmann 1967, 1969, Baldwin and Bainbridge 1993, CDFG 1995).

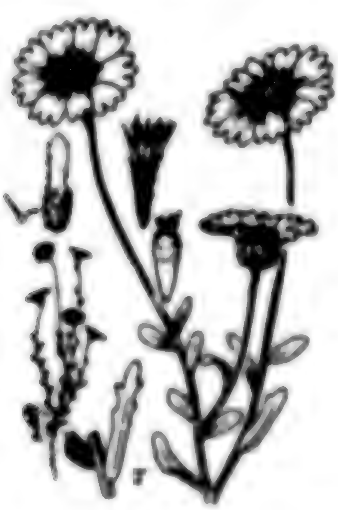

Figure 26. Illustration of Comanche Point layia (from Abrams and Ferris Vol. 4, 1960, with permission)

Reasons for Decline and Threats to Survival.—The formerly extensive occurrences of Comanche Point layia on the Valley floor apparently have been eliminated by conversion to agriculture (Twisselmann 1967, 1969, CDFG 1995). Populations in the Comanche and Tejon Hills potentially are threatened by urban development and are subject to grazing (Skinner and Pavlik 1994).

Conservation Efforts.—Comanche Point layia has not received any formal protection. Conservation needs of the species are being considered during the development of the Kern County Valley Floor Habitat Conservation Plan (T. James pers. comm.).

Conservation Strategy.—To ensure long-term conservation of Comanche Point layia, the strategy is to protect at least five populations representing the full historic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. The highest-priority task to recover Comanche Point layia is to ensure that the extant populations are protected from development. Comanche Point layia could be protected jointly with Bakersfield cactus and Tejon poppy at Comanche Point if the appropriate microhabitats are included in a conservation area. Monitoring of the populations is necessary to determine if they are self-sustaining. If populations do not decline, changes in land use are not necessary. Surveys for Comanche Point layia are also important in alkali sinks and can be conducted concurrently with those for Bakersfield smallscale and other halophytes. Comanche Point layia also may be rediscovered during surveys for Bakersfield cactus, California jewelflower,

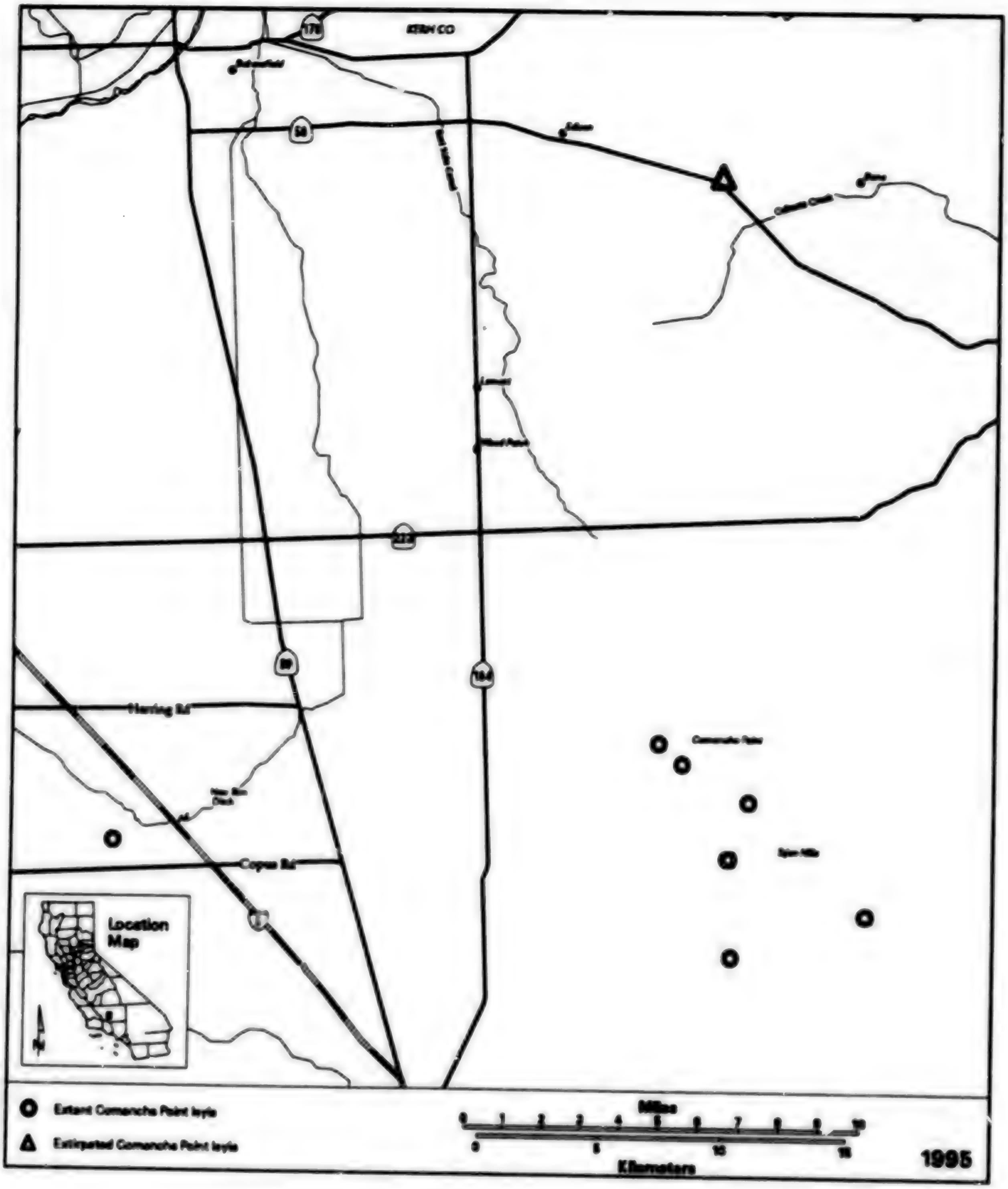

Figure 27. Distribution of Comanche Point layia (*Layia leucopappa*).

Vasek's clarkia, and Tejon poppy in the Comanche and Bena Hills. Collection of a representative seed sample (Center for Plant Conservation 1991) from the Comanche-Tejon Hills metapopulation and any discovered in disjunct areas is recommended to preserve genetic material because the distribution of this species is so limited. Also, if the Gator Pond area is protected for Bakersfield smallscale and Buena Vista Lake shrew, Comanche Point layia potentially could be reintroduced. The status of Comanche Point layia should be reevaluated within 5 years of recovery plan approval or when surveys have been completed, whichever is less.

9. Munz's Tidy-tips
(Layia munzii)

Taxonomy.—Keck (1935) named Munz's tidy-tips (*Layia munzii*) in the same publication in which he described Comanche Point layia. The type locality for Munz's tidy-tips is "32 miles (51 kilometers) east of Paso Robles" in San Luis Obispo County (Keck 1935, p. 17). The scientific name has not changed (Baldwin and Bainbridge 1993).

Description.—Munz's tidy-tips (Figure 28) is closely related to Comanche Point layia but the two species differ in appearance. The stems of Munz's tidy-tips may trail along the ground or grow upright, the leaves are not fleshy, and the ray florets are yellow with white tips. Munz's tidy-tips closely resembles the common tidy-tips (*L. platyglossa*) and the rare Jones' tidy-tips (*L. jonesii*). These three species are distinguished by subtle characteristics of the flower heads and achenes. Also, Jones' tidy-tips has purple streaks on the stem, unlike Munz's tidy-tips (Munz and Keck 1959, Abrams and Ferris 1960, Hoover 1970, Baldwin and Bainbridge 1993).

Historical Distribution.—Historically, Munz's tidy-tips was widespread in the western San Joaquin Valley and inner Coast Ranges from Fresno south (Figure 29). In Fresno County, the species was collected near Firebaugh, Little Panoche Creek, Mendota, the town of San Joaquin, and Wheatville. In San Luis Obispo County, Munz's tidy-tips occurred from the Cholame Valley (where the type specimen was collected) to the Carrizo Plain (Hoover 1937, 1970, Twisselmann 1956, CDFG 1995). The species was described as occasional in Kern County (Twisselmann 1967), but the only specific locations reported were west of Wasco and near Elmo (CDFG 1995). According to Abrams and Ferris (1960), Munz's tidy-tips also occurred in Merced County.

Current Distribution.—Extensive colonies of Munz's tidy-tips remain on the Carrizo Plain, ranging from the area southeast of Soda Lake to California Valley (Lewis 1997). This species also was observed in the vicinity of Lost Hills (Kern County) during the late 1980s. The Wasco and Elmo occurrences have been eliminated; other historical populations have not been revisited in 30 or more years (CDFG 1995).

Life History and Habitat.—Munz's tidy-tips is an annual that flowers during March and April. Cross-pollination is required for seed set (Munz and Keck 1959). Other facets of the life history have not been studied. Munz's tidy-tips grows on alkaline clay in low-lying areas and on hillsides in grasslands, Valley Saltbush Scrub, and Valley Sink Scrub. Associated species may include red brome, annual fescue, Lost Hills saltbush, common tidy-tips, iodine bush, and spiny saltbush (Hoover 1937, Munz and Keck 1959, Twisselmann 1967, Hoover 1970, Skinner and Pavlik 1994, CDFG 1995, Lewis 1997). On the Carrizo Plain, Munz's tidy-tips is confined to the spiny saltbush zone of the Soda Lake basin. It barely overlaps in range with common tidy-tips, which grows in slightly higher areas (Lewis 1997). Historical and current sites ranged from 45 to 800 meters (150 to 2,600 feet) in elevation (CDFG 1995, Lewis 1997).

Reasons for Decline.—Both Kern County

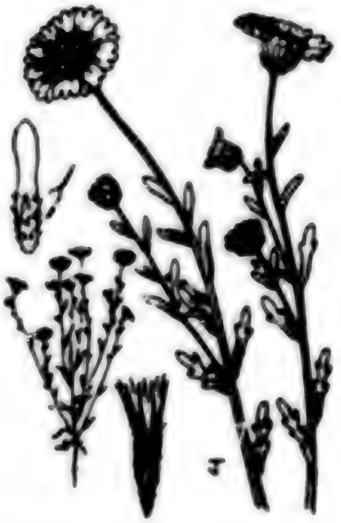

Figure 28. Illustration of Munz's tidy tips (from Abrams and Ferris Vol. 4, 1960, with permission).

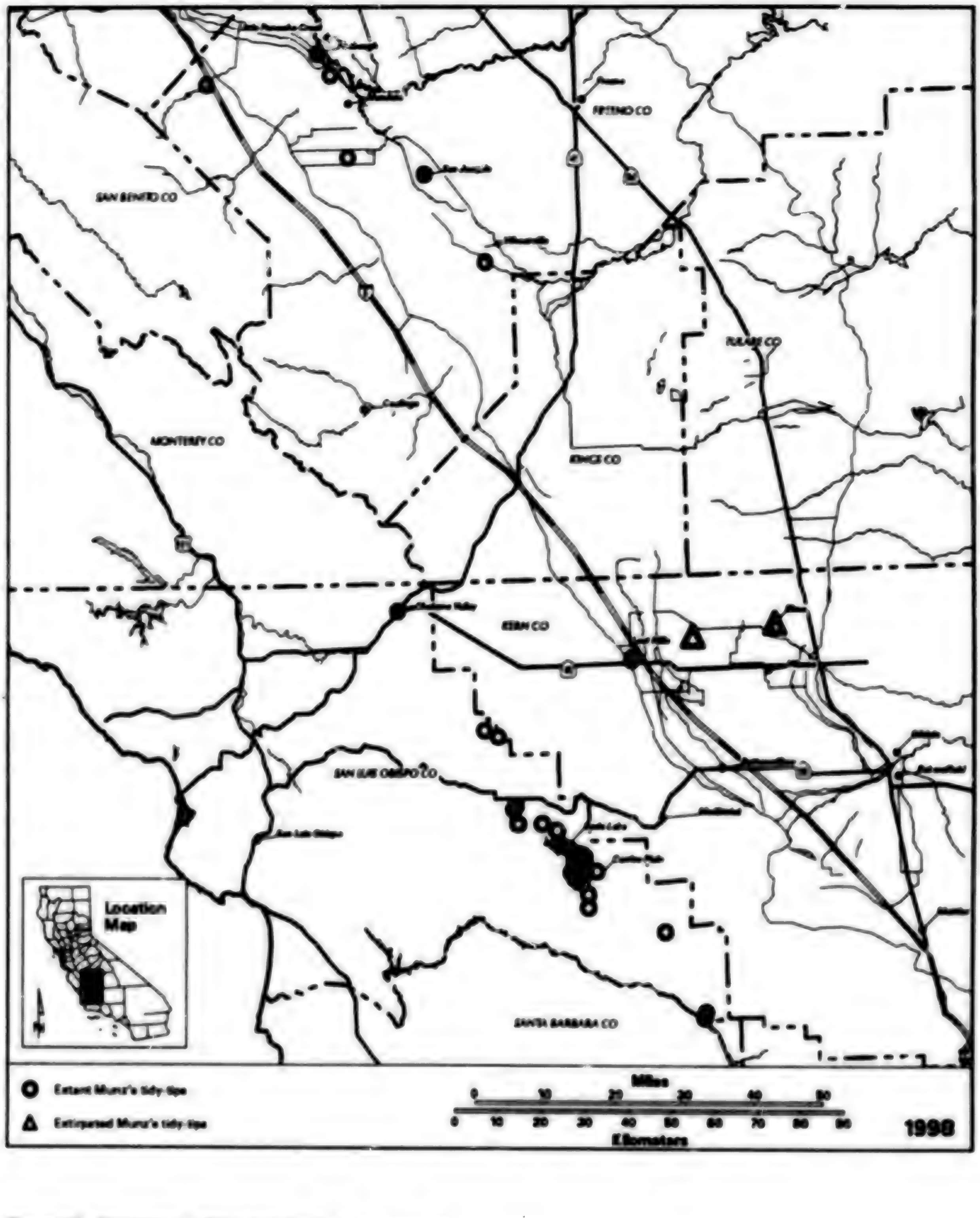

Figure 29. Distribution of Munz's tidy-tips *(Layia munzii)*.

occurrences of Munz's tidy-tips were destroyed by conversion to agriculture. Many low-lying areas in Fresno, Kern, and San Luis Obispo Counties have been cultivated, which may have destroyed other populations.

Threats to Survival.—The recently-observed site near Lost Hills is on an airport runway and therefore is subject to continued disturbance. If other Valley-floor sites remain extant, they could be threatened by agricultural conversion and commercial development. A small portion of the Carrizo Plain metapopulation is subject to cattle grazing, but no detrimental effects have been observed to date (Lewis 1997).

Conservation Efforts.—Russ Lewis of USBLM conducted surveys for Munz's tidy-tips on the Carrizo Plain Natural Area (Lewis 1997). The public land portion of the Carrizo Plain metapopulation is in a designated Area of Critical Environmental Concern; USBLM plans to manage the area for the perpetuation of rare species, including Munz's tidy-tips (USBLM 1996*ab*, Lewis 1997). This species also may occur in reserves on the San Joaquin Valley floor, such as the Center for Natural Lands Management's Semitropic Ridge, or USBLM's Kettleman Hills Area of Critical Environmental Concern, but its presence remains to be verified.

Conservation Strategy.—To ensure long-term conservation of Munz's tidy-tips, the strategy is to protect at least five populations representing the full historic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. The presence of this species on public lands does not negate the need for protection elsewhere. Protection from development and incompatible uses is equally important on both public and private lands. Surveys are necessary to determine the current status of historical populations as well as threats facing each occurrence (Skinner and Pavlik 1994). Extant populations should be protected from any site-specific threats and monitored regularly. Munz's tidy-tips could benefit from survey and protection efforts for listed species, including palmate-bracted bird's-beak, Fresno kangaroo rat, and Tipton kangaroo rat, and for species of concern such as Lost Hills saltbush and Jared's peppergrass. When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Munz's tidy-tips should be reevaluated.

10. Jared's Peppergrass
(*Lepidium jaredii*)

Taxonomy.—*Lepidium jaredii* was named by Brandegee (1894). Jared collected the type specimen "near Goodwin, San Luis Obispo County" (Brandegee 1894, p. 398). Hoover (1966) divided the species into two subspecies: Panoche peppergrass (*L. jaredii* ssp. *album*) and Carrizo peppergrass (*L. jaredii* ssp. *jaredii*). The type locality for Panoche peppergrass is "Arroyo Hondo wash north of Cantua Creek, Fresno County" (Hoover 1966, p. 345). The type locality for Carrizo peppergrass is by definition the same as that for the entire species. Although the most recent treatment of the genus (Rollins 1993) did not differentiate between the subspecies, California Native Plant Society (Skinner and Pavlik 1994) follows Hoover's taxonomy. Jared's peppergrass is in the mustard family.

Description.—Jared's peppergrass (Figure 30) varies from 10 to 70 centimeters (4 to 28 inches) in height, and the stems may be branched. It has narrow leaves, which occasionally have a few teeth on the margins. Each plant has many tiny flowers, which are distributed along the upper portions of each branch. The flattened, egg-shaped fruits contain two seeds each (Munz and Keck 1959, Rollins 1993). Panoche peppergrass has white flowers and numerous branches, whereas Carrizo peppergrass has yellow flowers and few branches (Hoover 1937, 1966, Taylor et al. 1990).

Historical Distribution.—Jared's peppergrass ranged from San Benito County south to San Luis Obispo County, with Panoche peppergrass occupying the northern portion of the species' range (Figure 31). Locations mentioned in the literature prior to 1966 can be assigned to a subspecies only tentatively. Apparently, collections from Arroyo Hondo, Little Panoche Creek, Panoche Creek, Riverdale, south of Mendota, and 20 miles northeast of Corcoran (all in Fresno County), and between Panoche and Idria in San Benito County represent Panoche peppergrass (Hoover 1966, CDFG 1995, Taylor et al. 1990). Carrizo peppergrass was reported historically from the Carrizo Plain (including the type locality) and Estrella in San Luis Obispo County (Brandegee 1894, Hitchcock 1936, Twisselmann 1956, Hoover 1970).

Current Distribution.—Currently, Panoche peppergrass is known or presumed to be extant at approximately 15 occurrences. The majority of the sites, including Arroyo Hondo and Panoche Creek, are in the Ciervo-Panoche region of Fresno and San Benito Counties (CDFG 1995, Taylor et al. 1990, Beehler in litt. 1994). One or two sites may remain in southern Fresno County and another in the Orchard Peak area of San Luis Obispo County (Skinner and Pavlik 1994). Carrizo peppergrass remains extant on the Carrizo Plain Natural Area; the extensive colonies east and southeast of Soda Lake comprise a single metapopulation (Lewis 1997). Two other occurrences of Carrizo peppergrass have been discovered recently: Padrones Canyon in the eastern foothills of the Caliente Mountains in San Luis Obispo County, and the Devil's Den area in Kern County (CDFG 1995, Taylor et al. 1990, Lewis 1997).

Life History and Habitat.—Both subspecies of Jared's peppergrass are annuals. Germination requirements have not been reported for either taxon. Panoche peppergrass flowers from February to June and Carrizo peppergrass from March to May (Skinner and Pavlik 1994), but few plants bloom in dry years (Hoover 1937). In 1997, Carrizo peppergrass germinated in January (Lewis 1997). Both taxa have been reported from clay and from sandy soils. Panoche peppergrass occurs in dry stream beds, on alluvial fans, and on slopes. Associated species include a variety of grasses and forbs as well as the shrubs common saltbush, quailbush *(Atriplex lentiformis)*, mulefat *(Baccharis salicifolia)*, and scalebroom *(Lepidospartum squamatum)* (Hoover 1970, CDFG 1995, Taylor et al. 1990, Beehler in litt. 1994, Lewis in litt. 1994, Lewis 1997). Carrizo peppergrass may occur in association with spiny saltbush, Lost Hills saltbush, alkali daisy *(Lasthenia ferrisiae)*, alkali peppergrass *(Lepidium dictyotum)*, and a few other plant species in the low-lying, alkaline areas east and southeast of Soda Lake. However, in open areas without spiny saltbush Carrizo peppergrass often forms dense, single-species stands. Carrizo peppergrass grows in a slightly lower part of the Soda Lake basin than does Munz's tidy-tips. Soils in these lower areas remain saturated for extended periods and frequently have a black or whitish surface crust (Lewis 1997). In Padrones Canyon, Carrizo peppergrass grows on steep, south-facing slopes and on the ridgetop where isolated areas of alkaline soil occur. The primary associate in these areas is hillside daisy *(Monolopia lanceolata)* Lewis in litt. 1994, Lewis 1997). Both subspecies of Jared's peppergrass are found below 1,000 meters (3,300 feet) in elevation (CDFG 1995, Taylor et al. 1990, Beehler in litt. 1994, Lewis in litt. 1994, Lewis 1997).

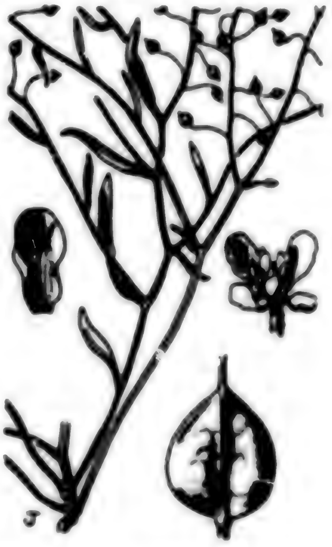

Figure 30. Illustration of Jared's peppergrass (from Abrams, Vol. 2, 1944, with permission).

Reasons for Decline and Threats to Survival.—Panoche peppergrass populations have been subject to disturbance from sand and gravel quarrying. Trampling by cattle is a possible threat to populations of this subspecies (Skinner and Pavlik 1994, CDFG 1995, Taylor et al. 1990, Beehler in litt. 1994). Carrizo peppergrass does not seem to have declined. The only potential threats noted were sheep grazing at Devil's Den and a minor possibility of cattle trampling on the Carrizo Plain (CDFG 1995, Lewis 1997).

Conservation Efforts.—In 1988, Dean Taylor of BioSystems Analysis, Inc. and biologists from the Hollister Resource Area of USBLM began surveys for Panoche peppergrass in both historical locations and suitable habitats. After they discovered the Fresno and San Benito County populations, USBLM acquired several of the sites that were on private land and now protects them from mining (CDFG 1995, Taylor et al. 1990, Beehler in litt. 1994, D. Taylor pers. comm.). The Orchard Peak area is also on public land (USBLM 1993). Russ Lewis of USBLM conducted surveys for and mapped occurrences of Carrizo peppergrass in 1997 (Lewis 1997). The Carrizo Plain and Padrones Canyon populations of Carrizo peppergrass are in USBLM's Carrizo Plain Area of Critical Environmental Concern, which is managed primarily for the benefit of rare species (Lewis in litt. 1994, USBLM 1996*a,b*).

Conservation Strategy.—To ensure the long-term

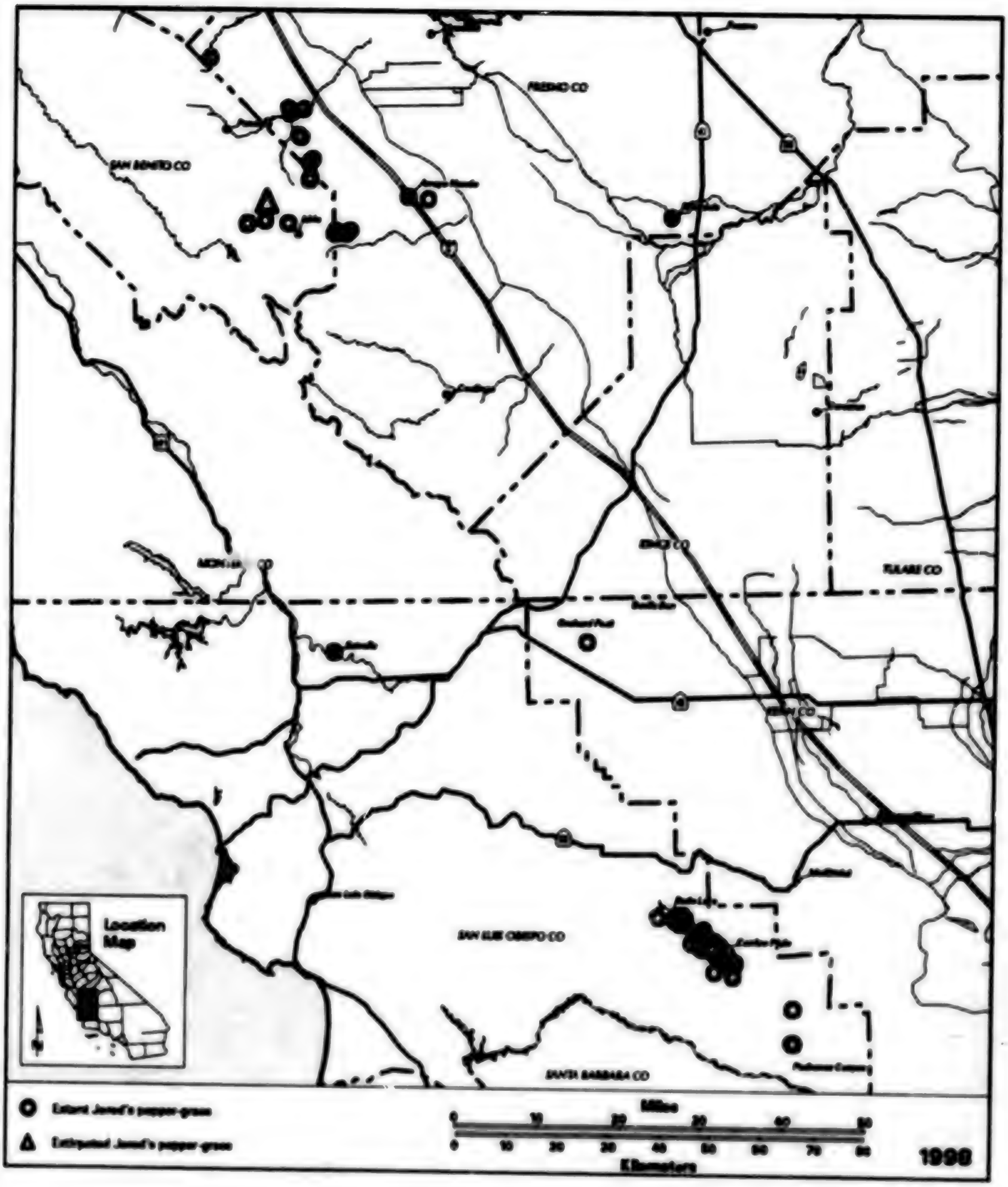

Figure 31. Distribution of Jared's peppergrass *(Lepidium jaredii)*.

conservation of Jared's peppergrass, the strategy is to protect at least five distinct populations of each subspecies, representing the full geographic range of the species. However, the more populations, the greater the likelihood of long-term survival for the species. Therefore, as many populations as possible should be protected, even though more than five currently are known from public lands. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Protection from development and incompatible uses is equally important on both public and private lands. The most important task to ensure the survival of Jared's peppergrass is to exclude severe surface-disturbing activities such as mining and land conversion within occupied areas. Light grazing may continue where impacts have not been observed. However, population monitoring is necessary; if declining population trends are noted, management changes may be necessary. Field inventories for both subspecies also should be continued, particularly in wet years, to verify the status of historical populations and arrange for their protection. When surveys have been completed or at a maximum within 10 years of recovery plan approval, the status of Jared's peppergrass should be reevaluated.

11. Merced Monardella
(Monardella leucocephala)

Taxonomy.—Merced monardella is known today by the scientific name published by Gray (1867), *Monardella leucocephala*. The type specimen was collected in Merced County on the plains near the Merced River (Epling 1925). Greene transferred Merced monardella to the genus *Madronella* in 1906, but Epling (1925) returned the species to *Monardella*. The scientific name has not been altered since (Jokerst 1993, Stebbins 1993). Merced monardella is a member of the mint family (Lamiaceae).

Description.—Merced monardella (Figure 32) has square stems 15 to 20 centimeters (6 to 8 inches) tall. Both the stems and the opposite, lance-shaped leaves are gray-hairy and have a characteristic mint scent. Although the white flowers are tiny, the flower heads are showy because each one is surrounded by a circle of white bracts. Merced monardella can be distinguished from the related species Sierra monardella (*M. candicans*) and coyote-mint (*M. villosa*) by the color of the stems, bracts, and flowers; microscopic differences in the flowers; and habitat (Munz and Keck 1959, Jokerst 1993).

Historical and Current Distribution.—Historically, Merced monardella was collected from five individual sites that were clustered in two areas: (1) near the Merced River south of Delhi in Merced County (including the type locality); and (2) along the Tuolumne River near La Grange and Waterford in Stanislaus County (Figure 33). The most recent record of the species was from 1941 (Skinner and Pavlik 1994, CDFG 1995, Stebbins 1993). Merced monardella was not found at historical sites during surveys from 1990 through 1992, but may persist on private lands where access was denied (Stebbins 1993).

Life History and Habitat.—This annual plant may grow only in years of above-average precipitation; it flowers in May, June, and July after the soil dries. Merced monardella is restricted to extremely sandy, subalkaline soils in low-lying areas bordering rivers. The native vegetation in these areas is grassland, but several collections were made in dry-farmed fields. The only associated species mentioned by collectors was naked buckwheat (*Eriogonum nudum*). Elevations at the historical sites range from approximately 15 to 80 meters (50 to 260 feet) (Hoover 1937, CDFG 1995, California

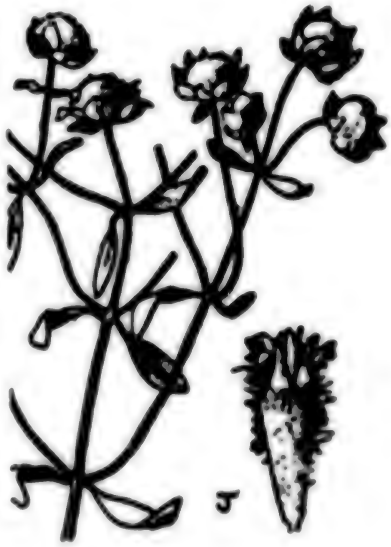

Figure 32. Illustration of Merced monardella (from Abrams, Vol. 3, 1951, with permission).

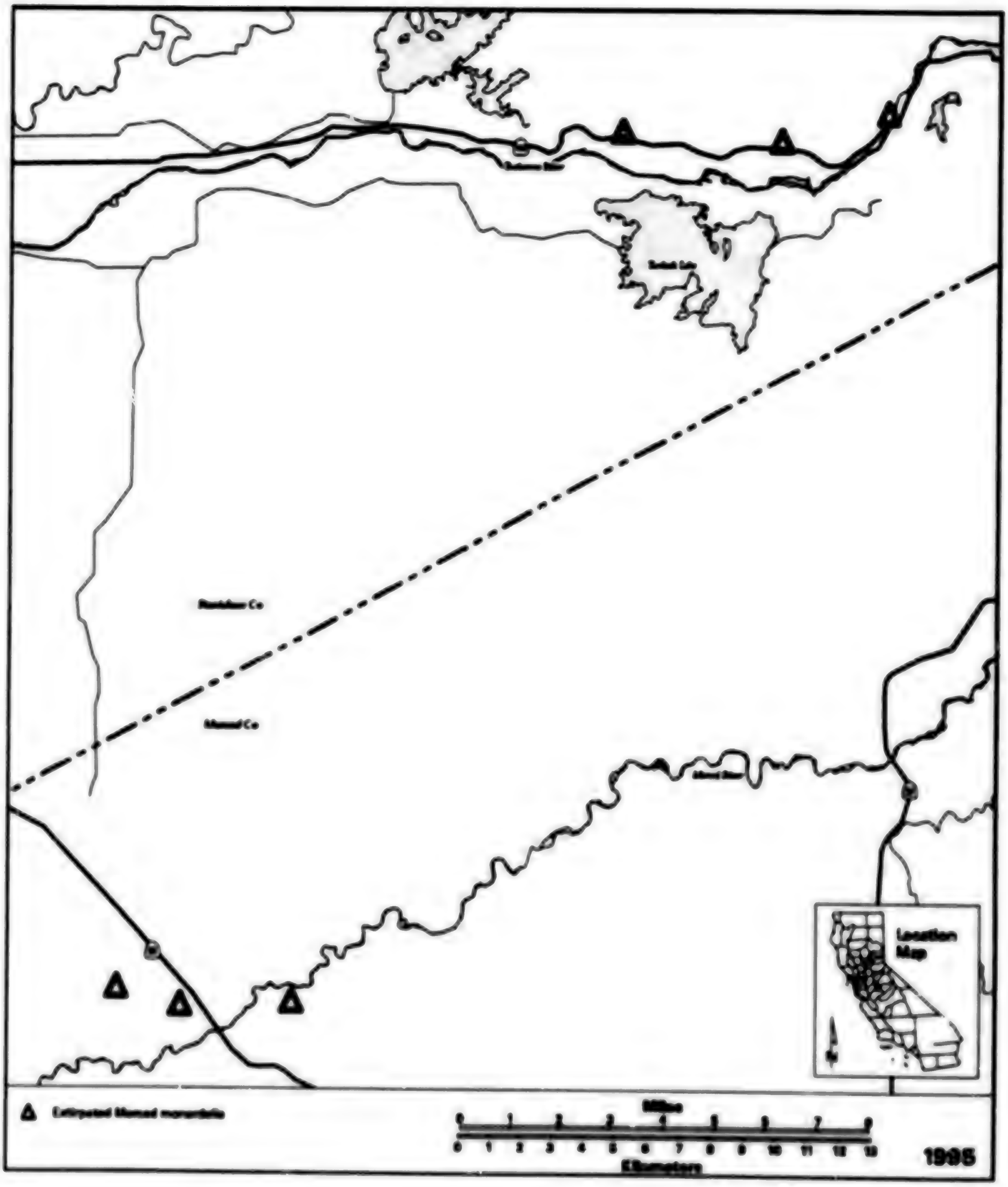

Figure 33. Distribution of Merced monardella (*Monardella leucocephala*).

Native Plant Society 1988*b*, Stebbins 1993).

Reasons for Decline and Threats to Survival.—Much of the suitable habitat for Merced monardella was converted to agriculture more than 50 years ago (Hoover 1937). The intensive, irrigated agriculture practiced today is incompatible with survival of this species, unlike the dry-land grain farming common in the past. Other activities that may have contributed to its decline include urban development and sand and gold extraction. The remaining suitable habitats that may support undiscovered populations are primarily in private ownership and thus are subject to these same threats (CDFG 1995, California Native Plant Society 1988*b*, Stebbins 1993).

Conservation Efforts.—USFWS sponsored a status survey for Merced monardella, which included field surveys from 1990 through 1992. California Native Plant Society has stressed the importance of conducting surveys for Merced monardella, although this species has been listed as "presumed extinct" pending rediscovery (Skinner and Pavlik 1994, Skinner et al. 1995).

Conservation Strategy.—To ensure long-term conservation of Merced monardella, the strategy is to protect at least five distinct populations. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Surveys for Merced monardella must be continued in both historical sites and suitable habitats, especially in years of above-average precipitation. The cooperation of private landowners is a prerequisite for surveys at some sites, and therefore an incentive program should be devised. If any populations are found, site-specific threats must be determined and negated. Monitoring should be initiated in all populations if the species is rediscovered. The status of Merced monardella should be reevaluated within 5 years of recovery plan approval or when surveys have been completed, whichever is less.

12. Merced Phacelia

(Phacelia ciliata var. opaca)

Taxonomy.—Howell (1936) published the name *Phacelia ciliata* var. *opaca* for Merced phacelia. He cited the type locality as "clay hills 5 miles northeast of Merced, Merced Co." (Howell 1936, p. 221). Authors of subsequent floras (Abrams 1951, Munz and Keck 1959, Wilken et al. 1993) considered Merced phacelia to be merely a minor variant of the Chinese-lantern phacelia (*P. ciliata*) that did not warrant formal taxonomic recognition. Nonetheless, California Native Plant Society (Skinner and Pavlik 1994) continues to treat Merced phacelia as a distinct variety. This taxon is a member of the waterleaf family (Hydrophyllaceae).

Description.—Merced phacelia (Figure 34) reaches a maximum height of 55 centimeters (22 inches). The leaves vary in both size and shape, ranging from 3 to 15 centimeters (1 to 6 inches) long and from deeply-lobed to divided. Each branch tip is coiled like a scorpion's tail and holds many flowers. The individual flowers are approximately 1 centimeter (0.5 inch) long, bell-shaped, and blue with pale centers. The *calyx*, which is the group of leaf-like structures below the petals, has five *ciliate* (with stiff hairs along the margin) *lobes* (free tips of parts that are fused at the base). The calyx is inconspicuous while the flowers are open; as the fruits mature, the calyx lobes elongate and become opaque (hence variety *opaca*). Conversely, in Chinese-lantern phacelia the calyx lobes grow broader and remain translucent at maturity (Wilken et al. 1993, Constance 1979).

Historical and Current Distribution.—Merced phacelia was collected in east-central Merced County near the towns of Le Grand, Merced, Planada, and Tuttle

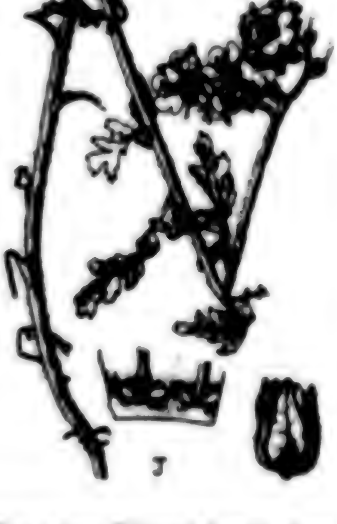

Figure 34. Illustration of Merced phacelia (from Abrams, Vol. 3, 1951, with permission).

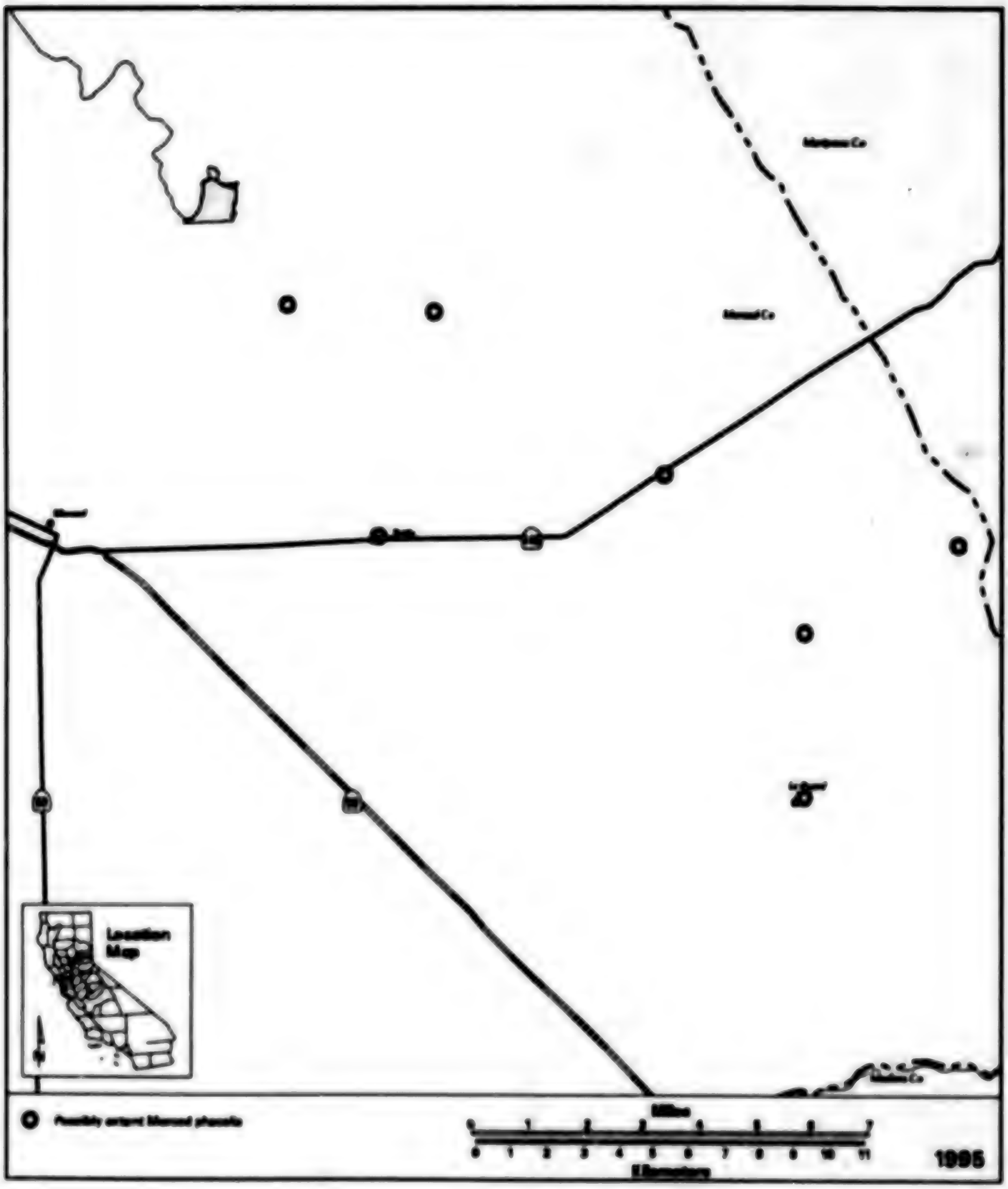

Figure 35. Distribution of Merced phacelia (*Phacelia ciliata* var. *opaca*).

between 1929 and 1939 (Figure 35). A very small population, consisting of fewer than 10 individuals, was observed in 1977 approximately 10 kilometers (6 miles) northeast of Merced. The other historical locations have not been visited for over 50 years due to a lack of access (Howell 1936, Skinner and Pavlik 1994, CDFG 1995, Constance 1979).

Life History and Habitat.—This annual plant flowers between February and May. Merced phacelia is restricted to heavy clay soils on the Valley floor and adjacent low hills at elevations below 100 meters (328 feet). Other aspects of its life history and habitat have not been reported (Howell 1936, Hoover 1937, Skinner and Pavlik 1994, Constance 1979).

Reasons for Decline and Threats to Survival.—Merced phacelia is rare by virtue of its restricted range. Most historic populations are inaccessible, therefore, no estimate can be given of the species relative abundance. The historical sites do not face any known threats at this time, though development of the planned University of California campus east of Merced and the consequent induced growth should be considered a significant threat.

Conservation Efforts.—No conservation measures have been instituted for Merced phacelia.

Conservation Strategy.—Cooperation of property owners will be key to protecting this taxon. To ensure the long-term conservation of Merced phacelia, the strategy is to protect at least five distinct populations. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. The first step will be for qualified botanists to obtain permission to survey historical locations to determine the current status of populations. Prospects for the persistence of Merced phacelia will be favorable if the majority of the populations remain extant and are free from threats. The second step, should any occupied habitats be found to face major threats, will be to pursue conservation easements, and identify and address site-specific management needs. Research into the taxonomy and genetics of the *Phacelia ciliata* complex could determine whether this taxon deserves recognition (Skinner et al. 1995), but it is a low-priority task. When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Merced phacelia should be reevaluated.

13. Oil Neststraw
(*Stylocline citroleum*)

Taxonomy.—Oil neststraw was recently recognized as a distinct species, *Stylocline citroleum* (Morefield 1992), even though herbarium specimens were collected as early as 1883. Munz collected the type specimen in 1935 from flats near Taft, in Kern County (Morefield 1992). Oil neststraw is believed to have originated as a hybrid of two common species, everlasting neststraw (*Stylocline gnaphaloides*) and California filago (*Filago californica*). However, oil neststraw satisfies the definition of a species because it is capable of reproducing itself without further crossing of the parental species (Morefield 1992). Oil neststraw is a member of the aster family.

Description.—Oil neststraw is inconspicuous because it grows low to the ground and does not have showy flowers. It has trailing, woolly stems less than 13 centimeters (5 inches) long and small, woolly leaves. The round flower heads are 5 millimeters (0.2 inch) or less in diameter. Each flower head contains many individual florets, which consist of reproductive parts and papery scales covered with woolly hairs. The fruits are tiny, brown achenes. Oil neststraw is difficult to distinguish from closely related species because the identifying characters are microscopic (Morefield 1992, 1993).

Historical Distribution.—Five populations of oil neststraw were known historically, based on collections made from 1883 to 1935 (Figure 36). Four of the occurrences were in Kern County, in the vicinities of Bakersfield, McKittrick, and Taft (two sites, including the type locality). The fifth collection was made in San Diego County.

Current Distribution.—Oil neststraw is known currently from Elk Hills and the nearby Coles Levee Ecosystem Preserve in western Kern County (Figure 36) (Enterprise Advisory Services, Inc. 1997, 1998, QUAD 1997, Jay Hinshaw pers. comm.). The status of other western Kern County occurrences is unknown; although natural land remains at most sites, the location descriptions are vague. The east Bakersfield and San Diego occurrences are less likely to remain due to rapid development in those areas.

Life History and Habitat.—Oil neststraw, an annual, flowers in April and reproduces strictly by self-

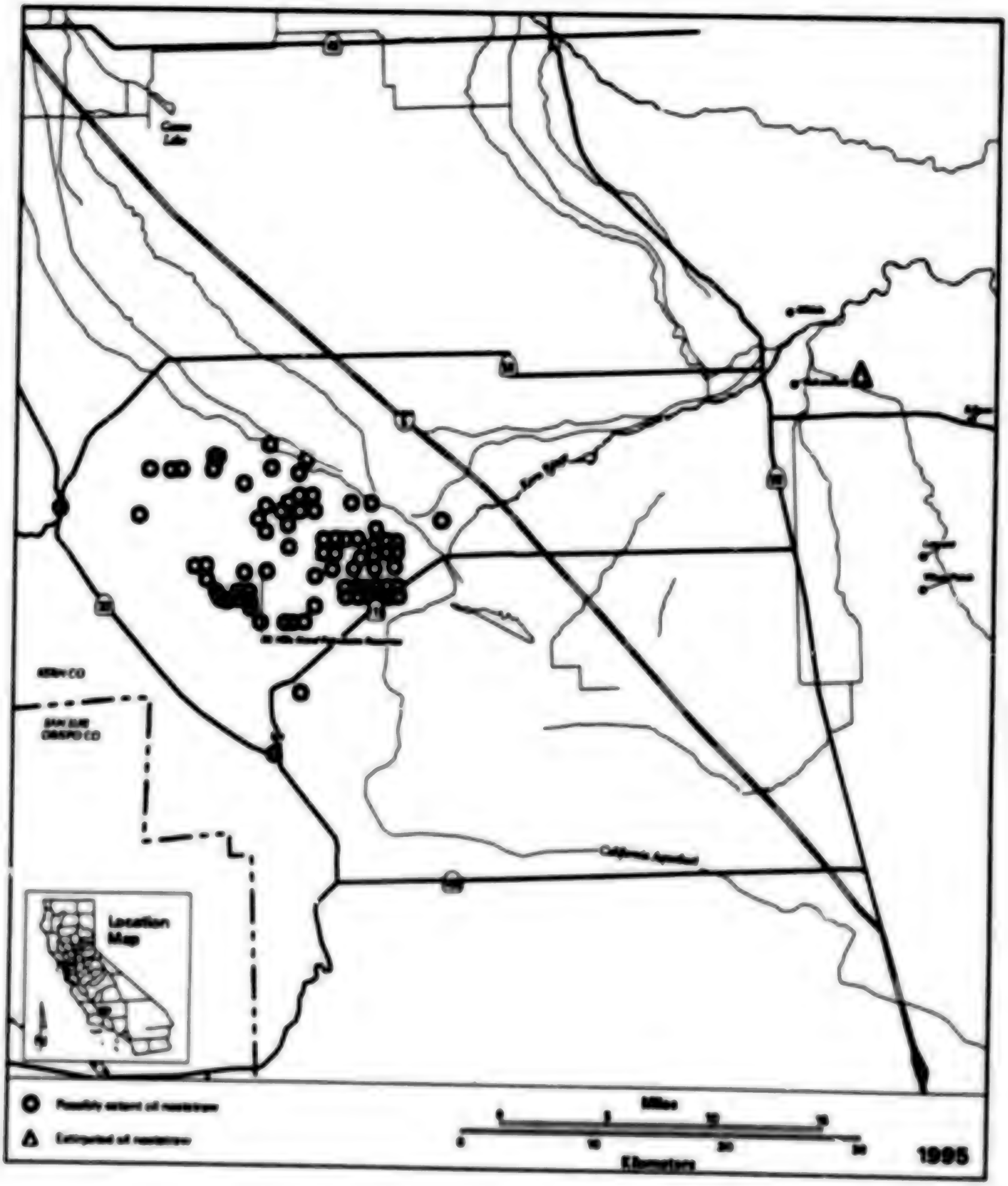

Figure 36. Distribution of oil neststraw *(Stylocline citroleum)*

pollination. The extant occurrences and several of the historical localities are in petroleum-producing areas, giving rise to both the common and scientific names. This species grows on flats and on slopes. One of the Elk Hills populations of oil neststraw occurs on the bank of a wash in a very sparsely vegetated area that has well-developed cryptogamic crust. The few plant species associated with oil neststraw at that site are natives such as everlasting neststraw, California filago, Hoover's woolly-star, and many-flowered eriastrum. Plant species that occur with oil neststraw in the other Elk Hills sites are red brome, common saltbush, and white burrobush (*Hymenoclea salsola*). All the extant occurrences are in the Valley Saltbush Scrub plant community in undeveloped areas. Oil neststraw has been found at elevations of 60 to 320 meters (200 to 1,050 feet) on both sandy and clay soils (Morefield 1992, EG&G Energy Measurements unpublished data, D. Taylor pers. comm.).

***Reasons for Decline and Threats to Survival*.**—Urban development has almost certainly eliminated the historical populations of oil neststraw in the vicinities of San Diego and Bakersfield, and possibly the one near Taft (Skinner and Pavlik 1994). Petroleum production is the primary use in the other areas where oil neststraw occurred historically, but actual population losses to oilfield activities have not been documented. The known populations on Elk Hills are not in an area with high potential for oil extraction (B.L. Cypher pers. comm.). However, any surface-disturbing activities would be detrimental to oil neststraw (J. Morefield pers. comm.).

***Conservation Efforts*.**—Most conservation efforts to date for oil neststraw have been accomplished by U.S. Department of Energy and their contractors in the Endangered Species and Cultural Resources Program at Elk Hills. Floristic surveys funded by the U.S. Department of Energy (1995–1997) and Occidental Petroleum (1998) revealed the presence of numerous new occurrences of oil neststraw scattered throughout Elk Hills (Enterprise Advisory Services, Inc. 1997, 1998, J. Hinshaw pers. comm.). Oil neststraw also was discovered at the adjacent Coles Levee Ecosystem Preserve during surveys funded by ARCO Western Energy (QUAD 1997). Morefield verified the identity of Elk Hills specimens collected through 1997. J. Hinshaw has developed a field key to oil neststraw and related species to facilitate identification and to permit mapping of occurrences, and he has conducted workshops to train local biologists in recognizing the species (J. Hinshaw pers. comm.). U.S. Department of Energy entered into a voluntary agreement with USFWS to protect four of the known populations on Elk Hills while the area was in government ownership. One or more of these occurrences are likely to be included in the conservation area that Occidental Petroleum will set aside in 1998 (B.L. Cypher pers. comm.).

***Conservation Strategy*.**—The strategy for oil neststraw is similar to that for other species of concern: to protect at least five distinct populations representing the full geographic range of the species in the San Joaquin Valley. The known occurrences at Elk Hills represent a single metapopulation and collectively constitute one of the five required populations. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes.

Several tasks are necessary to ensure long-term conservation of oil neststraw. First, the local populations at Elk Hills must be protected from disturbance (deliberate or accidental) for the foreseeable future. Occidental Petroleum could accomplish this goal by including representative populations of oil neststraw in their Elk Hills conservation area. Next, intensive surveys should be undertaken in suitable habitats throughout the southern San Joaquin Valley. The species has been overlooked in the past because it is so small, because it grows intermixed with superficially similar plants, and because it was not recognized as a species until 1992. However, the availability of keys based on both field and microscopic characters and Morefield's willingness to identify questionable specimens should overcome most limitations to species identification. The nature and magnitude of threats should be determined for all populations that are discovered, and steps should be taken to prevent habitat loss or degradation. In addition, site factors should be characterized to provide clues to the species' habitat requirements. Representative populations should be monitored annually to evaluate population trends. The status of oil neststraw should be reevaluated within 5 years of recovery plan approval.

H. GIANT KANGAROO RAT
(DIPODOMYS INGENS)

1. Description and Taxonomy

Taxonomy.—*Dipodomys ingens* was described as *Perodipus ingens* by Merriam (1904*a*), who listed the type locality as Painted Rock, 20 miles SE Simmler, Carrizo Plain, San Luis Obispo County, California. The type locality was amended to 41 kilometers (25 miles) SE of Simmler by Williams and Kilburn (1991). The genus name *Perodipus* was used for several years to include all the kangaroo rats with five toes on the hind feet. Grinnell (1921) relegated *Perodipus* to a synonym of *Dipodomys*. This taxonomy has been sustained in the latest taxonomic review of the family Heteromyidae (Williams et al. 1993*a*).

Description.—The giant kangaroo rat is adapted for bipedal locomotion (two-footed hopping) (Eisenberg 1963). The hind limbs are large compared to the size of the forelimbs; the neck is short; and the head is large and flattened. The tail is longer than the combined head and body length and has a dorsal crest of long hairs towards the end of the tail, terminating in a large tuft (Figure 37). Large, fur-lined cheek pouches open on each side of the mouth. The pouches extend as deep invaginated pockets of skin folded inward along the sides of the head (Grinnell 1922).

Identification.—Giant kangaroo rats are distinguished from the coexisting species, San Joaquin kangaroo rat (*D. nitratoides*) and Heermann's kangaroo rat (*D. heermanni*), by size and number of toes on the hind foot. The hind feet of adult giant kangaroo rats each have five toes and are longer than 47 millimeters (1.85 inches) (Best 1993). The giant kangaroo rat is the largest of more than 20 species in the genus (Grinnell 1922, Hall 1981, Best 1993). Grinnell (1932*a*) reported a mean mass of 157.0 grams (5.54 ounces) for 15 adult males and 151.4 grams (5.34 ounces) for 7 adult females. Adult Heermann's kangaroo rats average 65 to 80 grams (2.29 to 2.82 ounces), with maximum weights not exceeding about 90 grams (3.17 ounces) (Williams 1992); the hind foot also has five toes but individuals' feet usually measure less than 45 millimeters (1.77 inches) (Best 1993). Average weight of San Joaquin kangaroo rats is less than 45 grams (1.59 ounces), and they have four toes on each hind foot. Length of the hind foot does not exceed 39 millimeters (1.54 inches) (Grinnell 1922).

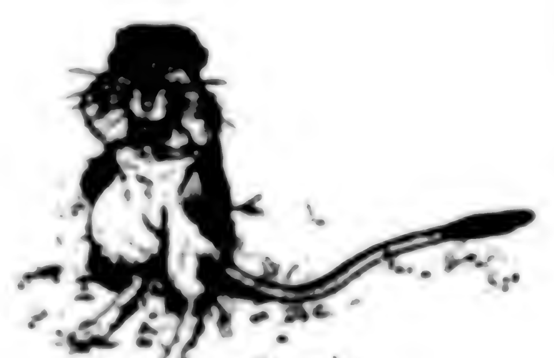

Figure 37. Illustration of the giant kangaroo rat (drawing by Jodi Sears, based on photo © by D.F. Williams).

2. Historical and Current Distribution

Historical Distribution.—Up until the 1950s colonies of giant kangaroo rats were spread over hundreds of thousands of acres of continuous habitat in the western San Joaquin Valley, Carrizo Plain, and Cuyama Valley (Grinnell 1932*a*, Shaw 1934, Hawbecker 1944, 1951). The historical distribution of giant kangaroo rats encompassed a narrow band of gently sloping ground along the western edge of the San Joaquin Valley, California, from the base of the Tehachapi Mountains in the south, to a point about 16 kilometers (10 miles) south of Los Banos, Merced County in the north; the Carrizo and Elkhorn Plains and San Juan Creek watershed west of the Temblor Mountains, which form the western boundary of the southern San Joaquin Valley; the upper Cuyama Valley next to and nearly contiguous with the Carrizo Plain; and scattered colonies on steeper slopes and ridge tops in the Ciervo, Kettleman, Panoche, and Tumey Hills, and in the Panoche Valley (Figure 38). Within this circumscribed geographic range were about 701,916 to 755,844 hectares (1,734,465 to 1,867,723 acres), which included different estimates of the amount of nonhabitat depending on different assumptions. The most liberal estimate of historical habitat was about 631,724 hectares (1,561,017 acres; Williams 1992).

Current Distribution.—The species population is currently fragmented into six major geographic units: A) the Panoche Region in western Fresno and Eastern San Benito Counties; B) Kettleman Hills in Kings County; C) San Juan Creek Valley in San Luis Obispo County D) western Kern County in the area of the Lokern, Elk Hills,

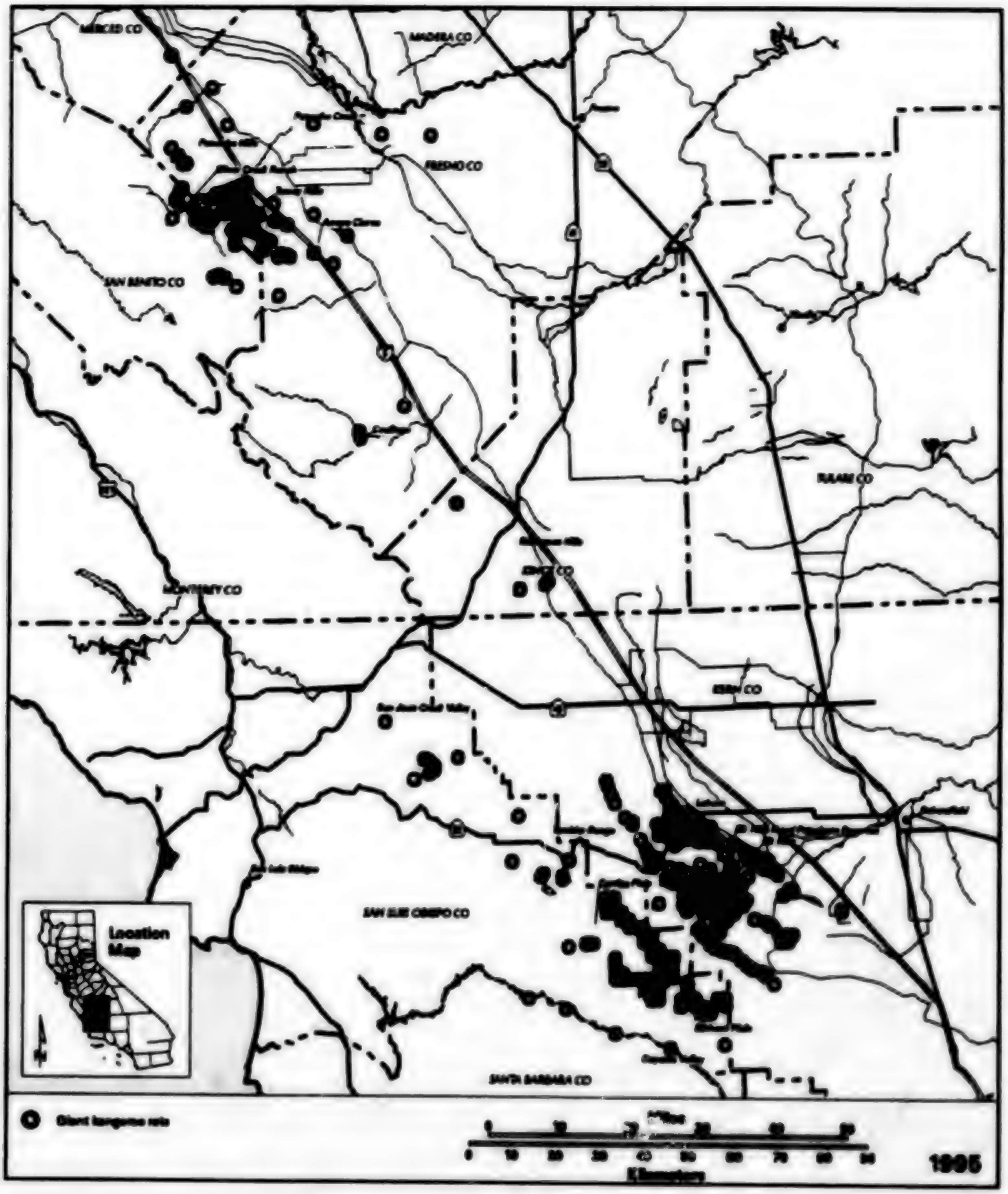

Figure 38. Distributional records of the giant kangaroo rat *(Dipodomys ingens)*.

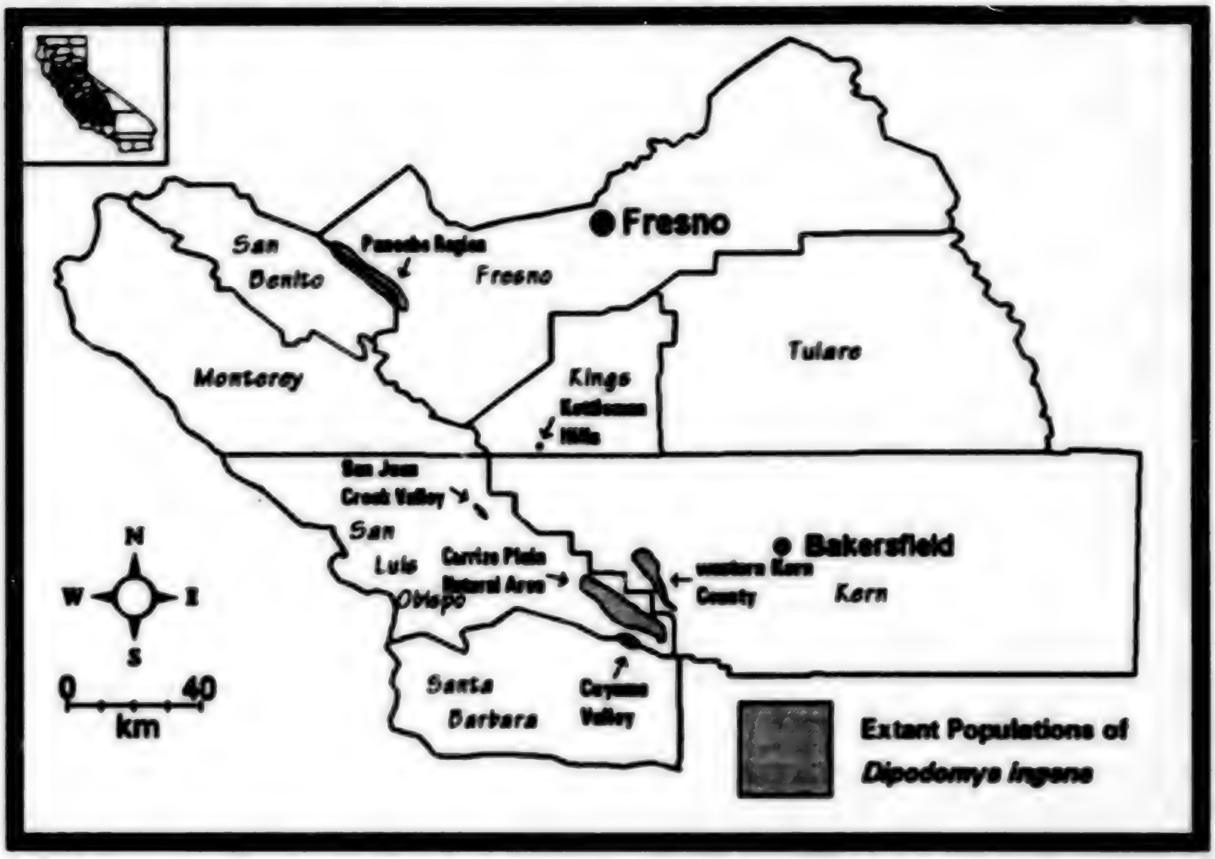

Figure 39. Locations of extant populations of giant kangaroo rats *(Dipodomys ingens)*.

and other uplands around McKittrick, Taft, and Maricopa; E) Carrizo Plain Natural Area in eastern San Luis Obispo County; and F) Cuyama Valley in Santa Barbara and San Luis Obispo Counties (Figure 39; Williams 1980, 1992, O'Farrell et al. 1987*a*, Williams et al. 1995). These major units are fragmented into more than 100 smaller populations, many of which are isolated by several miles of barriers such as steep terrain with plant communities unsuitable as habitat, or agricultural, industrial, or urban land without habitat for this species. Extant habitat was last estimated to be 11,145 hectares (27,540 acres), about 1.8 percent of historical habitat (Williams 1992).

Within the area of currently occupied habitat, populations of giant kangaroo rats have expanded and declined with changing weather patterns since 1979. At their peak in 1992 to 1993, there probably were about 6 to 10 times more individuals than at their low point in spring of 1991, when a majority of the 11,145 hectares (27,540 acres) probably was uninhabited and most of the rest was inhabited by less than 10 percent of peak numbers (Williams 1992, Williams et al. 1993*b*, Williams et al. 1995, Allred et al. in press, Williams and Nelson in press, D.F. Williams unpubl. data).

3. Life History and Habitat

Food and Foraging.—Giant kangaroo rats are primarily seed eaters, but also eat green plants and insects. They cut the ripening heads of grasses and forbs and cure them in small surface pits located on the area over their burrow system (Shaw 1934, Williams et al. 1993*b*). They also gather individual seeds scattered over the ground's surface and mixed in the upper layer of soil. Surface pits are uniform in diameter and depth (about 2.5 centimeters, 1 inch), placed vertically in firm soil, and filled with seed pods. After placing seeds and seed heads in pits, the animal covers them with a layer of loose, dry dirt. Pits are filled with the contents of the cheek pouches after a single trip to harvest seeds. Before being moved underground, the seeds, including filaree and peppergrass *(Lepidium nitidum)*, are sun-dried which prevents molding (Shaw 1934).

Individuals in many populations of *D. ingens* also make large stacks of seed heads on the surfaces of their burrow systems (Hawbecker 1944, Williams et al. 1993*b*). The material is cured, then stored underground. Amounts cached in surface stacks may not correspond with annual herbaceous productivity. No stacks were found in 1990, a year with no seed production, and 1991, a year with the second highest plant productivity between 1987 and 1994 (Williams and Nelson in press).

Grinnell (1932*a*, p. 313) examined three nursing females who had their cheek pouches "literally crammed with green stuff", and speculated that green foliage might be an important part of the diet during lactation. Other individuals, including a young female and adult males, were captured with foliage and fruits of peppergrass and foliage of filaree in their cheek pouches (Grinnell 1932*a*). In captivity, giant kangaroo rats have been maintained for periods from 2 weeks to more than 2 years on a diet of air-dried seeds, consisting primarily of millet, oat, and sunflower, occasionally supplemented with green plants. Of the green plants, captives preferred forbs to annual grasses, and usually ignored the blades of perennial grasses (Williams and Kilburn 1991). Shaw (1934) found a live insect of the bee and wasp family in the cheek pouch of a giant kangaroo rat. Eisenberg (1963) kept a giant kangaroo rat in captivity on a diet that included seeds, lettuce, and mealworm (darkling beetle) larvae (*Tenebrio* sp.).

Giant kangaroo rats forage on the surface from around sunset to near sunrise, though most activity takes place in the first 2 hours after dark. Foraging activity is greatest in the spring as seeds of annual plants ripen. Typically, plants such as peppergrass ripen first, and early caches, mostly in pits instead of stacks, consist of pieces of the seed-bearing stalks of this and other early-ripening species. The ability to transport large quantities of seeds and other food in cheek pouches and their highly developed caching behaviors, coupled with relatively high longevity of adults with established burrow systems, probably allow giant kangaroo rats to endure severe drought for 1 or 2 years without great risk of population extinction (Williams et al. 1993*b*, D.F. Williams unpubl. data).

Reproduction and Demography.—Results of studies conducted between 1987 and 1995 in colonies on the Elkhorn and Carrizo Plain indicated that giant kangaroo rats have an adaptable reproductive pattern that is affected by both population density and availability of food. During times of relatively high density, females have a short, winter reproductive season with only one litter produced and there is no breeding by young-of-the-year. This was true both in years of high plant productivity and drought. In contrast, populations at low densities continue to breed into summer during drought. In 1990, a year of severe drought and no seed production, most females appeared not to reproduce; the few that bred apparently failed to raise young. In most years, females were reproductive between December and March or April, but in colonies with low densities, reproduction extended into August or September (Williams et al. 1993*b*, Williams and Nelson in press, Endangered Species Recovery Program unpubl. data). Mating strategies are being studied on the Carrizo Plain by Dr. Jan Randall. Initial results indicate that mating strategies are flexible and may be responding to the age of males, proximity of females, and changes in sex ratios (Hekkala 1995).

Giant kangaroo rats can breed the year of their birth when environmental and social conditions permit (sufficient food and space). At the Soda Lake colony, juvenile females had their first litters at an estimated mean age of 5 months. Some females had two to three litters per year. This relatively high rate of reproduction probably was promoted by high plant productivity and low population density (Williams and Nelson in press).

Little information is available on age-specific litter size. The mean of known embryo counts and litter sizes is 3.75, probably a value higher than the number born (Williams and Kilburn 1991, D.F. Williams unpubl. data). Dr. Jan Randall's research showed that gestation was 30 to 35 days (Hekkala 1995). During a post-drought January through May breeding season, 44 percent of the litters contained two young. One female had a litter of three, the remaining 39 percent had a litter of one.

The major time for dispersal of giant kangaroo rats seems to be following maturation of young, about 11 to 12 weeks after birth. However in years of high density, when most or all burrow systems are occupied, most young appear to remain in their natal burrows until opportunity to disperse arises or they finally are driven off by the mother or one of the siblings. Under these circumstances, death or dispersal of the resident does not leave a burrow system vacant for long. Williams and Nelson (in press) found on a study site at Soda Lake, San Luis Obispo County that more females than males dispersed although males more often moved longer distances. Females had a nearly 60 percent greater survival rate than males. Dispersal of adults with established burrow systems was occasionally detected; one adult male moved more than 120 meters (131.2 yards) from his established home to take up a new residence in a new burrow system he constructed (Williams et al. 1993*b*, Williams and Nelson in press, Williams and Tordoff 1988).

Estimated home range size ranges from about 60 to 350 square meters (71.8 to 418.6 square yards). There is no significant difference in size of home range between sexes. The core area of the territory, located over the burrow system (*precinct*) is the most intensely used location in the home range (Braun 1985). Grinnell (1932*a)* and Shaw (1934) suggested that territories were occupied by a single animal. More recent studies indicate that multiple individuals may live in precincts. These appeared to be family groups of females and offspring of different ages (Randall 1997).

Estimates of density, employing both trapping and counts of precincts ranged from 1 to 110 animals per hectare (1 to 44 animals per acre) (Grinnell 1932*a*, Braun 1985, Williams 1992). Changes in density generally coincide with amount of rainfall and herbaceous plant productivity, though numbers in populations studied in 1989 remained high despite drought and low plant productivity (Figure 40). Large seed caches made in spring 1988 probably carried individuals through 1989 and 1990 during drought (Williams et al. 1993*b*, Williams and Nelson in press, D.F. Williams unpubl. data). The population on the Elkhorn Plain typically was at much higher density than other populations recently studied, and fluctuated less than populations elsewhere, suggesting that the habitat on this part of the Elkhorn Plain is some of the best remaining.

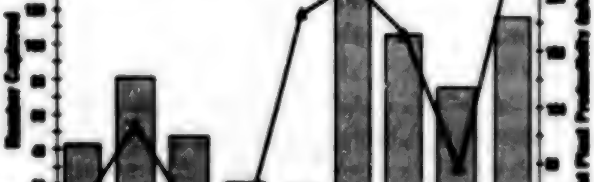

Figure 40. Numbers of giant kangaroo rats captured during August censuses, Elkhorn Plain. Census periods were 6 days in duration. The Y2 axis shows mean net plant productivity per square meter (Williams et al. 1993*b*, Endangered Species Recovery Program unpubl. data).

Population Genetics.—Partial results of on-going studies of population genetics of giant kangaroo rats provide guidance for designing a recovery strategy. The northern populations in Fresno and San Benito Counties are highly differentiated genetically from the southern populations on the Carrizo Plain Natural Area.

The genetic structure of the Carrizo Plain population differs from northern populations in that it has effectively acted as one large population, though the genetic data strongly suggest that the inhabited areas there have gone through episodes of substantial expansion and contraction in size (Mosquin et al. in press). This is consistent with recent observations from population censuses (Williams 1992, Williams et al. 1993*b*, Williams and Nelson in press, Allred et al. in press, D.F. Williams unpubl. data).

In the north, the population along the edge of the Valley at the eastern base of Monocline Ridge (San Joaquin Valley population) is substantially differentiated genetically from the other large population in the southeastern end of Panoche Valley (Figure 41). These two populations show little evidence of gene flow between them, and the San Joaquin Valley population is closer genetically to the Carrizo Plain population than any other of the semi-isolated northern populations. Clearly, this represents the remnant of the historical population that was distributed along the western edge of the Valley between Merced and Kern Counties. The two large, northern populations (San Joaquin Valley and Panoche Valley) appear to have been the sources of the small, semi-isolated populations on ridge-tops in the Ciervo and Tumey Hills. These latter populations are differentiated from both of the large populations, and from each other. They appear to have played the major role in gene flow between the Panoche Valley (Figure 41, see area B) and San Joaquin Valley populations. Interpopulation movements appear to have been achieved over relatively long periods in a stepping-stone manner between small populations on these ridge tops. Though small, they contain a significant proportion of the rare and unique genes of the northern population (Mosquin et al. in press).

The genetic studies show that *effective population size* (number of successfully-breeding individuals) in the

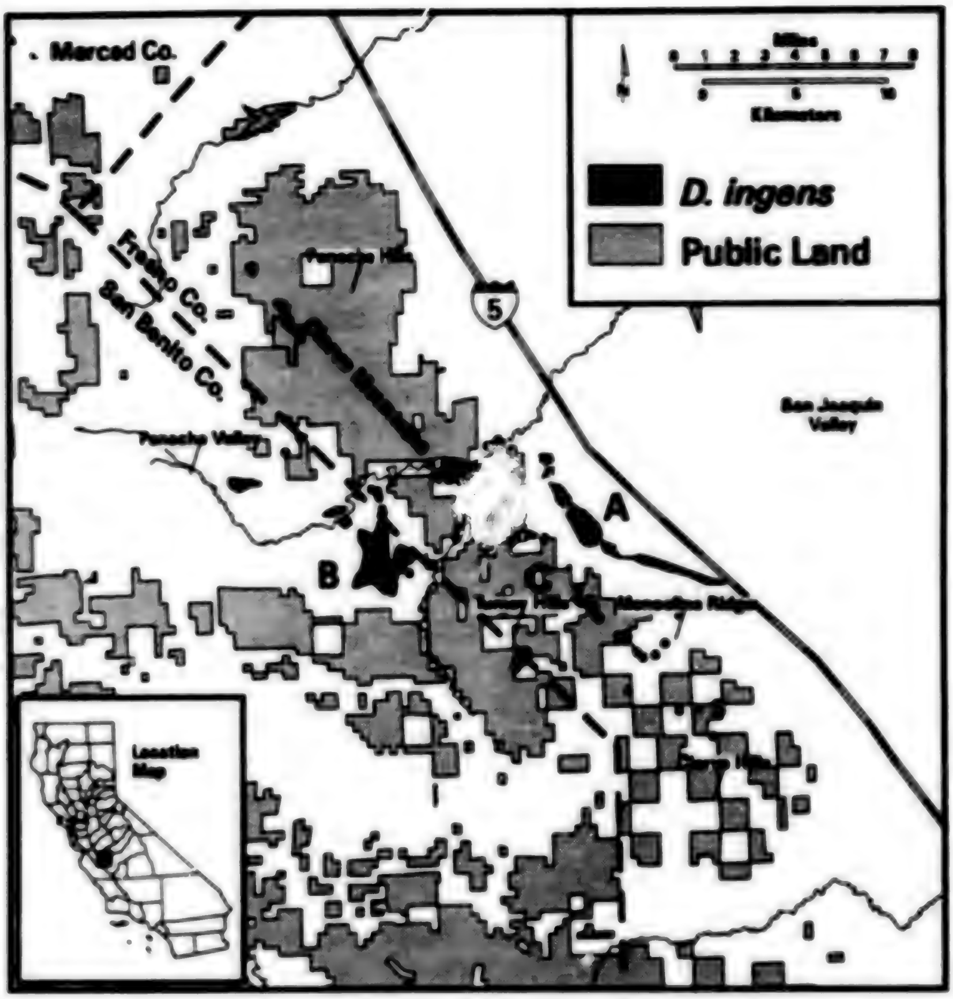

Figure 41. Distribution of extant colonies of giant kangaroo rats *(Dipodomys ingens)* in their northern geographic range (Williams et al. 1995). A—colonies along the eastern base of Monocline Ridge and the Tumey Hills; B—Panoche Valley colonies; C—colonies along the crest of the Ciervo Mountains.

north is smaller than current population size, indicating there has been a large increase in the northern population size very recently. This is consistent with the increase measured after the end of the drought in 1991 (Williams et al. 1995). In the south, estimated effective population size is slightly greater than current population size, indicating that current and historical population sizes are approximately the same (Mosquin et al. in press).

The genetic structure of giant kangaroo rat populations also shows that the *effective dispersal* distance of giant kangaroo rats (i.e., dispersal of genes) is much greater than predicted on the basis of capture-recapture and behavioral studies. Results from trapping of kangaroo rats show most movements are less than 100 meters (330 feet) and rarely as much as 1 kilometer (0.62 mile) (Jones 1988, 1989, Williams and Nelson in press). The genetic data suggest that effective distances are several times greater than 1 kilometer (0.62 mile). There are too few data, and analyses are too incomplete to make a precise estimate, but they do suggest effective dispersal over several kilometers and through highly inhospitable habitat in the northern population (Mosquin et al. in press).

Behavior and Species Interactions.—Little direct evidence exists on aggression by giant kangaroo rats, but they seem to be much more aggressive than the two co-occurring species. Wherever giant kangaroo rats were found by Grinnell (1932*a*), they dominated the community to the exclusion of other rodent species. Hawbecker (1944, 1951) and Tappe (1941) corroborated

Grinnell's observations, finding that giant kangaroo rats excluded all other nocturnal rodents from areas where they occurred.

Braun (1983), however, found that a population of giant kangaroo rats on the Carrizo Plain, San Luis Obispo County, did not exclude other species of rodents to the extent reported by others. Braun (1983) believed that the lack of exclusivity supported the hypothesis that this population was living in suboptimal habitat.

The giant kangaroo rat, by its relative abundance and burrowing activity, is a keystone species in grassland and shrub communities (Schiffman 1994, Goldingay et al. 1997). When abundant locally, giant kangaroo rats are a significant prey item for many species, including San Joaquin kit foxes (an umbrella species), American badgers (*Taxidea taxus*), coyotes (*Canis latrans*), long-tailed weasels (*Mustela frenata*), burrowing owls (*Athene cunicularia*), barn owls (*Tyto alba*), great horned owls (*Bubo virginianus*), and short-eared owls (*Asio flammeus*). Snakes seen within giant kangaroo rat colonies included the coachwhip (*Masti- cophis flagellum*), gopher snake (*Pituophis melano- leucus*), common king snake (*Lampropeltis getulus*), and western rattlesnake (*Crotalis viridis*; Williams 1992). Giant kangaroo rat burrows also are used by blunt-nosed leopard lizards and San Joaquin antelope squirrels. On the Carrizo Plain Natural Area, the endangered California jewelflower grows primarily on the burrow systems of giant kangaroo rats (Cypher 1994*a*). In spring, precincts show as distinct, evenly-spaced, dark green patches because of the more lush growth of herbaceous plants compared to intervening spaces (Grinnell 1932*a*). Measurements of plant productivity on and off precincts over an 8-year period show that when rainfall was sufficient to promote growth and fruiting of plants, the net productivity of herbaceous plants was two to five times greater on precincts than surrounding ground (Hawbecker 1944, Williams et al. 1993*b*, Williams and Nelson in press). Further, growth of herbaceous plants on precincts contained about 4 percent more protein than plants from surrounding ground. These differences were attributed directly to the presence and activities of the giant kangaroo rats (Williams et al. 1993*b*).

Activity Cycles.—Giant kangaroo rats are active all year and in all types of weather. They do not migrate or become dormant or torpid. Although primarily nocturnal, giant kangaroo rats have been seen above ground during daylight, including midday in the hottest part of the year (Williams et al. 1993*b*, Williams and Tordoff 1988). Giant kangaroo rats typically emerge from their burrows soon after sunset and are active for about 2 hours (time of first emergence to time of last disappearance). There usually is no second period of activity before dawn. Animals are above ground only for about 15 minutes per night. Activity patterns appear to be unaffected by distance from the home burrow, snow, rain, wind, moonlight, or season (Braun 1985).

Habitat and Community Associations.—Historically, giant kangaroo rats were believed to inhabit annual grassland communities with few or no shrubs, well-drained, sandy-loam soils located on gentle slopes (less than 11 percent) in areas with about 16 centimeters (6.3 inches) or less of annual precipitation, and free from flooding in winter (Grinnell 1932*a*, Shaw 1934, Hawbecker 1951). However, more recent studies in remaining fragments of historical habitat found that giant kangaroo rats inhabited both grassland and shrub communities on a variety of soil types and on slopes up to about 22 percent and 868 meters (2,850 feet) above sea level. This broader concept of habitat requirements probably reflects the fact that most remaining populations are on poorer and marginal habitats compared to the habitats of the large, historical populations in areas now cultivated. Yet these studies demonstrated that the preferred habitat of giant kangaroo rats still was annual grassland communities on gentle slopes of generally less than 10 percent, with friable, sandy- loam soils. Few plots in flat areas were inhabited, probably because of periodic flooding during heavy rainfall (Williams 1992, Williams et al. 1995, Allred et al. in press).

Below about 400 meters (1,300 feet) at Panoche Creek in western Fresno County and in the Lokern, Buena Vista Valley, and Elk Hills regions of the southern San Joaquin Valley, giant kangaroo rats are found in annual grassland and saltbush scrub. Scattered common and spiny saltbushes characterize areas where giant kangaroo rats are associated with shrubs. The most common herbaceous plants are red brome, annual fescue, and red-stemmed filaree (Williams 1992).

Upper Sonoran subshrub scrub associations support relatively large populations of giant kangaroo rats at elevations above about 400 meters (1,300 feet). In the southern portion of the extant geographic range of giant kangaroo rats, these communities are characterized by open stands of the dominant shrub, California ephedra. Annual grasses and forbs, particularly red-stemmed filaree, peppergrass, and Arabian grass dominate areas between shrubs. Giant kangaroo rats are most numerous where annual grasses and forbs predominate, with scattered ephedra bushes and fewer shrubs such as Anderson desert thorn *(Lycium andersonii)*, eastwoodia *(Eastwoodia elegans)*, and pale-leaf goldenbush *Isocoma acradenia* var. *bracteosa)* (Williams 1992).

Above about 600 meters (2,000 feet) in elevation, eastwoodia, California buckwheat, winter fat *(Krascheninnikovia lanata)*, and chaparral yucca (*Yucca whipplei*) are more common on steep slopes (greater than about 5 to 6 percent) and sandy ridgetops. Cheesebush *(Hymenoclea salsola)* and matchweed are common only in arroyos. Only satellite colonies of giant kangaroo rats or scattered individuals are found in these latter associations. In the northern portion of the geographic range of giant kangaroo rats, Anderson desert thorn is absent; otherwise, the woody shrubs comprising the ephedra community are the same or closely-related species (Williams 1992, Williams et al. 1995).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—Until the late 1960s and early 1970s, little land within the historical range of the giant kangaroo rat had been permanently cultivated and irrigated or otherwise developed. Completion of the San Luis Unit of the Central Valley Project and the California Aqueduct of the State Water Project resulted in rapid cultivation and irrigation of natural communities that had provided habitat for giant kangaroo rats along the west side of the San Joaquin Valley (Williams 1992, Williams and Germano 1993). Between about 1970 and 1979, almost all the natural communities on the western floor and gentle western slopes of the Tulare Basin were developed for irrigated agriculture, restricting occurrence of most species of the San Joaquin saltbush and Valley Grassland communities, including the giant kangaroo rat. This rapid habitat loss was the main reason for its listing as endangered. At the time of its listing, relatively little of its extant habitat was publicly owned or protected from possible destruction.

Use of rodenticide-treated grain to control ground squirrels and kangaroo rats also may have contributed to the decline of giant kangaroo rats in some areas. From the 1960s into the early 1980s rodenticides such as Compound 1080 were often broadcast over broad areas by airplane. Today, there are large areas in the Sunflower Valley (western corners of Kings and Kern Counties), Kettleman and Tent Hills in Kings County, and the eastern foothills of the Panoche Hills, Fresno County, that show characteristic features of giant kangaroo rat precincts, but are unoccupied by kangaroo rats. Williams (1992) believed that populations in these areas may have been eliminated by use of rodenticides.

Based on remarks by Grinnell (1932*a*) and Shaw (1934), giant kangaroo rats can survive in areas that have been grazed to a point where almost no plant material remains. It is not known, however, if they could survive indefinitely if those grazing intensities were sustained.

Destruction of natural communities to develop the infrastructure for petroleum exploration and extraction also has reduced habitat for giant kangaroo rats and contributed to their decline, especially in the area around Coalinga, Fresno County, and in the oil fields of western Kern County. The small cities and towns along the western edge of the San Joaquin Valley between Coalinga and Maricopa also have developed on what was once habitat for giant kangaroo rats. These developments, plus mineral extraction, roads and highways, energy and communications infrastructures, and agriculturally related industrial developments collectively have contributed to the endangerment of the giant kangaroo rat, but were not as important as loss of habitat by cultivation.

Threats to Survival.—Since listing as endangered (USFWS 1987), conversion of habitat for giant kangaroo rats has slowed substantially, because most tillable land has already been cultivated and because of a lack of water for irrigation. However, urban and industrial developments, petroleum and mineral exploration and extraction, new energy and water conveyance facilities, and construction of communication and transportation infrastructures continue to destroy habitat for giant kangaroo rats and increase the threats to the species by reducing and further fragmenting populations. Though many of these recent and future losses will be mitigated for by protecting habitat elsewhere, they still result in additional loss and fragmentation of habitat. Habitat degradation due to lack of appropriate habitat management on conservation lands, especially lack of grazing or fire to control density of vegetation (including shrubs) may be a threat to giant kangaroo rats (Williams and Germano 1993).

Though 60 population monitoring plots, range-wide, for giant kangaroo rats were established in 1995 by the Endangered Species Recovery Program (Williams and Kelly in litt. 1994*a*), there are no funds obligated to carry out a monitoring program in the future. Regular monitoring is important to any endangered species management program. Without monitoring, the effects of management prescriptions cannot be properly evaluated or altered in response to changes in populations due to both management actions and environmental variation. Perhaps no active management program is needed for giant kangaroo rat habitat, but that cannot be determined until after several years of range-wide monitoring and evaluation of effects of different land uses on populations.

The sale of Naval Petroleum Reserve #1 in Elk Hills to private interests (Henry 1995*a*, 1995*b*) could represent a threat to one of the three largest regional populations of giant kangaroo rats if rates of exploration and production are increased. The giant kangaroo rat population in western Kern County is isolated from all others, and though at times is fairly widespread, it seems especially sensitive to variable precipitation patterns, declining to only a few small areas during drought and after periods of heavy rainfall. Thus, its vulnerability to extinction by random catastrophic events (e.g., drought, flooding, fire) seems relatively high (B.L. Cypher pers. comm., T. Kato pers. comm., L. Spiegel pers. comm., Endangered Species Recovery Program unpubl. observ.). Any factor that would reduce substantially the amount of protected habitat in that region would pose a major threat to the population. The greatest value of the Naval Petroleum Reserves in California to giant kangaroo rats is the large extent of habitat of varying quality and its connectivity to adjacent habitat in the Lokern area. The publicly-owned portion of the Naval Petroleum Reserves in California ensures that giant kangaroo rat habitat will be protected during and after extraction of petroleum deposits.

Land in western Fresno County at the edge of irrigated ground provides an important area for recovery of the northern population of giant kangaroo rats (Williams et al. 1995) (Figure 39). The extant population on natural lands along the border of cultivated ground is split into two segments (Figure 41, see area A). One occupies only a narrow band about 6.44 kilometers (4 miles) long and from about 200 meters (660 feet) to 320 meters (1,050 feet) wide. The other, separated by only a few hundred meters, occupies about 250 hectares (617 acres) in an oval pattern about 2,400 by 1,200 meters (1.5 by 0.75 miles; Williams et al. 1995). Together, they support about 27 percent of the entire northern population in times of high population numbers, and probably more than 50 percent in times of lowest population numbers. This population represents the "up-slope" remnant of a formerly huge colony that stretched among the gentle slopes of the western edge of the Valley from around the alluvial fan of Laguna Seca Creek in Merced County, southward to Coalinga, a distance of about 97 kilometers (60 miles). During population irruptions it also is the "connector" population to small, scattered populations in the Ciervo and Tumey Hills, and along Panoche and Silver Creeks (Figure 41, see area C). The narrow band of habitat for this population is bisected lengthwise and degraded in quality by roads, power lines, and pipelines. Moderate levels of livestock grazing on this property probably have maintained nearly optimum conditions for giant kangaroo rats in what is only mediocre-quality habitat in comparison to historical habitat, but among the better-quality habitat remaining. Any additional loss or degradation of habitat from construction of permanent roads and energy conveyance facilities or cultivation could pose a substantial threat to the entire northern population.

Habitat for three of the six regional populations of giant kangaroo rats include no public or conservation lands (Figure 39). These are the populations in Cuyama Valley (about 194 hectares, 480 acres), Kettleman Hills (about 1 hectare, 2.47 acres), and San Juan Creek Valley (estimate unavailable because of lack of access to private land; Williams 1992). All are small and vulnerable to extinction from demographic and random catastrophic events (e.g., drought, flooding, fire), and inappropriate land uses that would degrade or destroy habitat.

5. Conservation Efforts

Designation as State (1980; Table 1) and federally (USFWS 1987) endangered has resulted in substantial habitat protection for giant kangaroo rats. Most significant has been protection on the U.S. Department of Energy Naval Petroleum Reserves in California in western Kern County (O'Farrell and Kato 1987, O'Farrell et al. 1987*a*, 1987*b*), and on USBLM-administered Federal properties (USBLM 1987, 1993). Acquisition of private property in the jointly managed Carrizo Plain Natural Area by the State of California, U.S. Government, and The Nature Conservancy (Table 2) has significantly reduced threats to the species from dryland cultivation and illegal use of rodenticides. It also has allowed for control of livestock grazing on this land by the change in ownership from private to public. Other significant acquisitions that have benefited conservation of giant kangaroo rats have been the land exchanges and purchases within western Fresno and eastern San Benito Counties by the USBLM, and compensation, donation, and acquisition of parcels in the Lokern area of western Kern County by the California Energy Commission, CDFG, and The Nature Conservancy (Table 2).

Substantial progress in understanding the current distribution, habitat associations, demography, and population genetics of giant kangaroo rats has been achieved by a series of research projects, mainly supported by USFWS section-6 funds and money from the Endangered Species Tax Checkoff Program and Environmental License Plate Program administered by the CDFG's Bird and Mammal Conservation Program (R. Schlorff pers. comm.). Additional funding and logistic support for research on giant kangaroo rats has been provided by the U.S. Bureau of Reclamation, USBLM, USFWS, and The Nature Conservancy. This research has been summarized in a series of reports and publications (Williams 1980, Williams 1992, Williams et al. 1993*b*, 1995, Allred et al. in press, Mosquin et al. in press, Williams and Nelson in press, Williams and Tordoff 1988). Additionally, substantial information on distribution, habitat, and population fluctuation has been provided by the U.S. Department of Energy through EG&G Energy Measurements for research conducted at the Naval Petroleum Reserves in California in western Kern County (O'Farrell and Kato 1987, O'Farrell et al. 1987*b*, EG&G Energy Measurements 1995*a,b*), and for the southern San Joaquin Valley (Anderson et al. 1991) and the Carrizo Plain Natural Area (Kakiba-Russell et al. 1991) by the California Energy Commission.

U.S. Environmental Protection Agency County bulletins governing use of rodenticides have greatly reduced the risk of significant mortality to giant kangaroo rat populations by State and county rodent-control activities. The California Environmental Protection Agency, California Department of Food and Agriculture, county agricultural departments, CDFG, and U.S. Environmental Protection Agency collaborated with the Service in the development of County Bulletins that both are efficacious and acceptable to land owners (R.A. Marovich pers. comm.).

6. Recovery Strategy

Recovery of giant kangaroo rats can be achieved when the three largest populations (western Kern County, Carrizo Plain Natural Area, and the Panoche Region) and the populations in the Kettleman Hills, San Juan Creek Valley and Cuyama Valley are protected and managed appropriately. Because the giant kangaroo rat is a keystone species, protection of the above areas will benefit many other listed species that share the same habitat types.

Information on reproductive rates and survivorship still is insufficient to adequately model population viability, though measured population growth strongly suggests that reproductive capacity of giant kangaroo rats is ample to rapidly rebuild depleted population numbers and to expand into newly available habitat. The principal factor in recovery of giant kangaroo rats is protection of existing habitat and key local populations within the three regional populations.

Current understanding of demographics, distribution (Williams 1992, Williams et al. 1993*b*, 1995, Allred et al. in press, Williams and Nelson in press), and population genetics (Mosquin et al. in press) of giant kangaroo rats is sufficient to presume that the species is not threatened by inbreeding, low reproductive rates, etc., though some small, isolated populations are at risk from these factors. Population responses to environmental variation seen during the last 16 years (Williams 1980, 1992, Williams et al. 1993*b*, Williams and Nelson in press, D.F. Williams unpubl. data) suggest that random catastrophic events (e.g., drought, flooding, prolonged rainfall) poses the greatest risk to long-term survival of the species. Protection from random catastrophic events requires both relatively large habitat areas with varying topography and habitat conditions, and land uses that provide optimum habitat conditions.

Recovery Actions.—Though substantial habitat for giant kangaroo rats is now in public ownership, recovering giant kangaroo rats requires additional habitat protection. Key to protection is an adequate understanding of compatible land uses and management prescriptions that provide optimum habitat conditions for giant kangaroo rats (Williams and Germano 1993). Several other listed species, including the California jewelflower, San Joaquin woolly-threads, blunt-nosed leopard lizard, San Joaquin antelope squirrel, and San Joaquin kit fox, seem to require the same or similar habitat conditions, so there is unlikely to be conflicts in habitat management prescriptions for most of the listed species where they coexist. Land acquisition, purchase of conservation easements, or other incentive mechanisms that will ensure that suitable habitat will be maintained in perpetuity also are needed to protect key local populations. Some existing public lands could be inhabited or support larger populations if suitably restored. Yet, available data are insufficient to know the types and amounts of compatible land uses or appropriate forms of habitat restoration and management. Recovery actions to protect habitat for giant kangaroo rats follow:

1. Of highest priority for habitat protection is proper land use and management on publicly-owned and conservation lands in the Carrizo Plain Natural Area, Naval Petroleum Reserves in California, Lokern Natural Area, and Ciervo-Panoche Natural Area. Where populations of giant kangaroo rats and associated, listed species appear to be robust, land use should not be changed when ownership or conservation status of parcels changes unless there are compelling reasons to do so. For land already in public and conservation ownership, historical uses that maintained habitat for giant kangaroo rats, such as livestock grazing, should be reestablished where appropriate.

2. Of equal priority is supporting research on habitat management and restoration, focusing on effects of livestock grazing on habitat quality, and habitat restoration on retired farmland, especially abandoned dryland farms.

3. Second in priority for habitat protection is the protection of additional land supporting key populations by acquisition of title, conservation easement, or other mechanisms. Areas to be protected are prioritized, as follows:

   a. (1) Land in the Lokern Area of western Kern County. The goal is to protect 90 percent of the existing natural land bounded on the east by natural lands just east of the California Aqueduct, on the south by Occidental of Elk Hills, on the west by State Highway 33, and on the north by Lokern Road;

      (2) Land in the Naval Petroleum Reserves in California of western Kern County. The goal is to maintain in a natural state (i.e., grassland and saltbush scrub communities) 90 percent of the existing natural land in Occidental of Elk Hills, and 80 percent of the natural land in Naval Petroleum Reserve in California No. 2, including all in the Buena Vista/McKittrick Valley between Elk Hills Road on the southeast and State Highway 33 on the northwest;

   b. Existing natural land providing habitat for giant kangaroo rats in western Fresno and eastern San Benito Counties. The goal is to protect all existing natural land on the Silver Creek Ranch, and existing habitat for this species along the eastern bases of Monocline Ridge and the Tumey Hills, between Arroyo Ciervo on the south and Panoche Creek on the north;

   c. Acquire and restore habitat on periodically farmed land with no or Class-3 irrigation water rights immediately east of occupied natural habitat along the strip described in 3.b, and west of Interstate Highway 5;

   d. Other natural land occupied by giant kangaroo rats in western Kern County. The goal is to protect 80 percent of existing habitat for giant kangaroo rats;

   e. Land occupied by giant kangaroo rats in the Cuyama Valley, Santa Barbara County;

   f. Land occupied by giant kangaroo rats in the Kettleman Hills, Kings County;

   g. Land occupied by giant kangaroo rats in the San Juan Creek Valley, San Luis Obispo County.

The above areas described in items e through g are important to the continued existence and recovery of other species, though it is not known if giant kangaroo rat populations have sufficient habitat in those areas to maintain viability indefinitely. Their keystone role in the ecosystem, however, makes it important to try to maintain these giant kangaroo rat populations.

A long-term program to periodically monitor populations range-wide is important to understanding population responses to random catastrophic events (e.g., drought, flooding, fire) and differing land uses, response to adaptive management, and to measure progress toward recovery. This program would measure responses of populations, key elements of their plant community, environmental variation, and soil erosion or formation to variation in climate and land uses (Williams and Kelly in litt. 1994*a*). Monitoring should be conducted annually for at least a 10-year period, and periodically thereafter at 5-year intervals.

I. FRESNO KANGAROO RAT
(DIPODOMYS NITRATOIDES EXILIS)

1. Description and Taxonomy

***Taxonomy*.**—The Fresno kangaroo rat is one of three subspecies of the San Joaquin kangaroo rat. The type specimen of the Fresno kangaroo rat was collected from Fresno, California, in 1891. Merriam (1894) considered the Fresno and the Tipton kangaroo rats to be subspecies of Merriam's kangaroo rat (*Dipodomys merriami*), a widespread species occurring in the Mojave Desert of California and elsewhere in western North America. Yet, Grinnell (1921) noted that the populations of "*D. merriami*" from the San Joaquin Valley were distinct from other members of this species. Grinnell (1922) subsequently reclassified *exilis* as a subspecies of a new species, the San Joaquin kangaroo rat *(D. nitratoides)*. Fresno and Tipton kangaroo rats are similar in overall structure and occupy contiguous geographic ranges on the floor of the Tulare Basin and southeastern half of the San Joaquin Basin in the San Joaquin Valley. A third subspecies, the short-nosed kangaroo rat, is found in the foothills and basins along the western side of the San Joaquin Valley south of Los Banos, Merced County on the north, and western portions of the Tulare Basin, the upper Cuyama Valley, and Carrizo Plain (Williams et al. 1993*a*).

Boolootian (1954) studied structural variation in populations of *D. nitratoides*, concluding that *exilis* did not merit recognition as a subspecies and regarded it to be a synonym of *nitratoides*. Hall and Kelson (1959) did not follow Boolootian's (1954) recommendation for reasons they attributed to the unpublished advice of Seth Benson (former Curator of Mammals, Univ. California, Berkeley, Museum of Vertebrate Zoology). In a master's thesis study of Fresno kangaroo rats, Hoffmann (1975) concluded that Benson erred in his determination of the identity of some San Joaquin kangaroo rats, but that *exilis* was identifiable as a subspecies. Williams (1985) agreed with Hoffmann's conclusions that the samples he regarded as *exilis* were distinguishable from those he had available of *nitratoides* and *brevinasus*, but noted that the subspecies were practically indistinguishable when samples of populations from localities intermediate to the geographic locations of Hoffmann's samples of *exilis* and *nitratoides* were included. DNA studies to resolve this issue are currently being conducted. Investigators using serum proteins (Johnson and Selander 1971, Patton et al. 1976, Best and Janecek 1992) and chromosome structure (Stock 1971, Patton et al. 1976) found substantial differences at the species level between *D. nitratoides* and *D. merriami*, supporting Grinnell's (1922) earlier species reclassification. Subspecies taxonomy of *D. nitratoides* was most recently reviewed by Williams et al. (1993*a*) and all were retained.

***Description*.**—The San Joaquin kangaroo rat is similar in general appearance to the other 20 species of kangaroo rats, but is smaller, and differs substantially from all other species in several ways (Figure 42). Like all kangaroo rats, the San Joaquin kangaroo rat is adapted for survival in an arid environment. Adaptations for bipedal locomotion include elongated hind limbs, a long, tufted tail for balance, a shortened neck, and, compared to typical rodents, a large head. The skull is flattened from top to bottom, with enlarged *auditory bullae* (bony capsules containing the middle and inner ears). Other characteristics include large eyes placed near the top of the head and small, rounded ears. Forelimbs are comparatively short with stout claws that facilitate

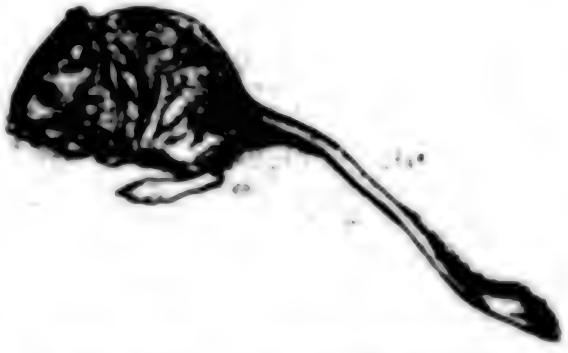

Figure 42. Illustration of a San Joaquin kangaroo rat *(Dipodomys nitratoides)* by Jodi Sears based on photo © by D.F. Williams.

digging burrows (Best 1991). Its total length averages about 231 millimeters (9.09 inches) for males and 225 millimeters (8.86 inches) for females (Hoffmann 1975). The hind foot usually is less than 36 millimeters (1.42 inches) in length. The fur is dark yellowish-buff dorsally and white ventrally (Knapp 1975). A white stripe extends across the hips, continuing for the length of the prominently tufted tail. The base of the tail is circumscribed by white. Dorsal and ventral sides of the tail are blackish. Dark whisker patches on each side of the nose are connected by a black band of fur (Grinnell 1922, Culbertson 1934, Williams 1985).

Identification.—The San Joaquin kangaroo rat can be distinguished from other kangaroo rats within its geographic range by the presence of four toes on the hind foot; the other species found in the same area have five toes. The Fresno kangaroo rat is the smallest of the three subspecies of *D. nitratoides*. Individuals of the three subspecies of *D. nitratoides* cannot be reliably distinguished without dissection unless the geographic origin of the individual is known. The Fresno kangaroo rat is distinguished from the other subspecies of the San Joaquin kangaroo rat by its smaller average measurements (in millimeters): length of hind foot for males 33.9 millimeters (1.33 inches), for females, 33.4 millimeters (1.31 inches); mean inflation of the auditory bullae for males, 21.4 millimeters (0.84 inch), for females, 21.2 millimeters (0.83 inch) (Hoffmann 1975) (see accounts of Tipton and short-nosed subspecies for corresponding average measurements).

2. Historical and Current Distribution

Historical Distribution.—The known historical geographic range of the Fresno kangaroo rat encompassed an area of grassland and chenopod scrub communities on the San Joaquin Valley floor, from about the Merced River, Merced County, on the north, to the northern edge of the marshes surrounding Tulare Lake, Kings County, on the south, and extending from the edge of the Valley floor near Livingston, Madera, Fresno, and Selma, westward to the wetlands of Fresno Slough and the San Joaquin River (Figure 43). Documentation of historical distribution is scanty. Boolootian (1954), Culbertson (1934, 1946), Hoffman and Chesemore (1982), Hoffmann (1974, 1975), Knapp (1975), Williams (1985), and Williams et al. (1993a) collectively provided a composite picture of the historical distribution and documentation of the loss and fragmentation of habitat. An estimate of the historical range, within the area as outlined above, is approximately 359,700 hectares (888,500 acres; Williams 1987). Not all this area would have been habitat for Fresno kangaroo rats.

Current Distribution.—There are no known populations within the circumscribed historical geographic range in Merced, Madera, and Fresno Counties. A single male Fresno kangaroo rat was captured twice in autumn 1992 on the Alkali Sink Ecological Reserve, west of Fresno. Trapping at the Reserve in 1993, 1994, and 1995 did not yield additional captures. Fresno kangaroo rats were previously trapped on the Alkali Sink Ecological Reserve in 1981 and 1985, and on adjacent privately owned land in 1981 (Hoffman and Chesemore 1982, Chesemore and Rhodehamel 1992). Though the Alkali Sink Ecological Reserve is now about 382.4 hectares (945 acres), suitable habitat there for Fresno kangaroo rats probably totals about 162 hectares (400 acres). Trapping at other sites in Merced, Madera, and Fresno Counties between 1988 and 1995 failed to locate other, extant populations within the area typically considered as the geographic range of the Fresno kangaroo rat (Chesemore and Rhodehamel 1992, Williams and Kilburn 1992, D.F. Williams unpubl. data).

Other areas of west-central Fresno County that were inhabited historically by Fresno kangaroo rats, and that were uncultivated in 1981, included nine separate sites. Two of the nine parcels now are partly cultivated but 715.7 hectares (1,768.4 acres) in two others were purchased by the State (now the Kerman Ecological Reserve). Fresno kangaroo rats have not been found at any of these sites during surveys between 1988 and 1996 (Endangered Species Recovery Program unpubl. data).

Populations of San Joaquin kangaroo rats have been found on about 150 hectares (371 acres) comprising five isolated parcels in Kings County, south of the historical river and slough channels of the Kings River and north of the Tulare Lake bed (Williams 1985, D.F. Williams unpubl. data). Staff of the Endangered Species Recovery Program last verified occurrence of two populations in 1994 and 1995. One site, 39 hectares (97 acres) in size, is located on Lemoore Naval Air Station. Whether these populations belong to the Fresno or Tipton subspecies is uncertain, but historically, they were geographically contiguous and probably periodically connected to populations identified as Fresno kangaroo rats. Genetic and morphometric studies (to measure the size of the feet and auditory bullae) of these populations are in progress (J.L. Patton pers. comm.).

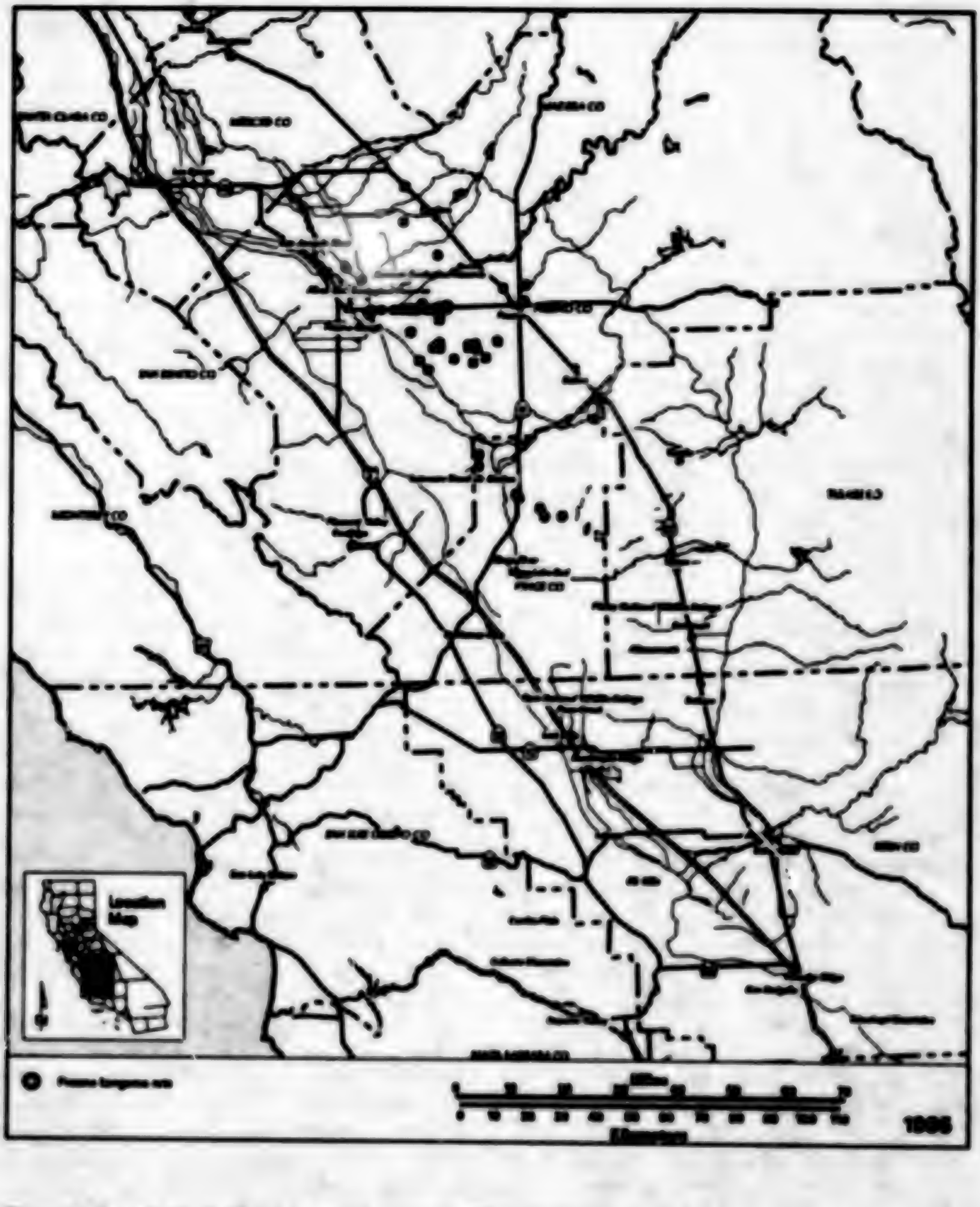

Figure 43. Distributional records for the Fresno kangaroo rat (*Dipodomys nitratoides exilis*).

Other areas with possibly extant populations of Fresno kangaroo rats include uncultivated grassland, alkali sink shrubland, and seasonally flooded wetlands within the historical range of the species, in Fresno, Madera, and Merced Counties. Trapping at selected sites in all three counties between 1988 and 1995 has failed to confirm presence, but lack of permission to trap on private lands has prevented a thorough search by staff of the Endangered Species Recovery Program. Populations of *D. nitratoides* occurred on the Mendota Wildlife Area, Fresno County, both east and west of the Fresno Slough, but the population west of Fresno Slough was regarded by Hoffmann (1975) as representing *D. n. brevinasus* rather than *exilis*, though they were intermediate to the two subspecies structurally (Boolootian 1954). Occurrence on the Wildlife Area has not been verified, despite trapping in 1981 and 1993.

San Joaquin kangaroo rats also have been taken recently in seasonally-flooded iodine bush *(Allenrolfea occidentalis)* shrublands in the South Grasslands Water District, Merced County. This population is located in an area historically considered part of the geographic range of the short-nosed subspecies. Individuals exhibit structural characteristics somewhat intermediate to *brevinasus* and *exilis*, but are found in the same habitat as *exilis* and have been tentatively assigned to *exilis* (Johnson and Clifton 1992, Williams et al. 1993*a*). These areas are privately owned lands included in the wetland waterfowl easement program of USFWS.

3. Life History and Habitat

Food and Foraging.—Fresno kangaroo rats collect and carry seeds in fur-lined cheek pouches. Seeds are a staple in their diet, but they also eat some types of green, herbaceous vegetation, and insects. A wide variety of seeds probably are consumed, depending on availability. Known foods include seeds of annual and perennial grasses, particularly wild oats, brome grasses (red and ripgut [*B. diandrus*] brome, soft chess [*B. hordeaceus*]), wild barley (*Hordeum* sp.), mouse-tail fescue, alkali sacaton, and saltgrass; and seeds of annual forbs such as filaree, peppergrass, common spikeweed (*Hemizonia pungens*), and shepherd's purse (*Capsella bursa-pastoris*) (Culbertson 1946, Koos 1979). Seeds of the woody and semiwoody shrubs, iodine bush and seepweed *(Suaeda moquinii)*, also are eaten (Koos 1979). Seeds of woody shrubs, especially saltbushes are diligently sought out by Tipton and short-nosed kangaroo rats, and also probably are important for Fresno kangaroo rats (D.F. Williams unpubl. *observ.*). Insects make up a small part of the diet, varying from about 2 to 10 percent frequency in fecal samples (Koos 1979).

Most kangaroo rats gather seeds when they are available and cache them for consumption later. Typically, caches are made in small pits that hold the contents of the two cheek pouches. Caches are located on the surface of the soil, and are typically scattered over the home range of the individual. A few, small, seed caches were found in excavated burrows of Fresno kangaroo rats (Culbertson 1946). These small caches also hold only about the contents of two cheek pouches. Culbertson (1946) speculated that Fresno kangaroo rats did not cache seeds in their burrows to the same extent as other kangaroo rats because the soil where they lived was damp much of the year. Seeds would spoil rapidly under such conditions. He also speculated that Fresno kangaroo rats therefore were obligated to forage on the surface year round to a greater extent than kangaroo rats that cached more food. In fall and winter, after the wet season commences, sprouts of seeds and tender new growth of grasses and forbs may be essential items in the diet of Fresno kangaroo rats. Green developing seed heads may be important in the spring months. Seeds, and perhaps insects, are the most important items in the diet in late spring, summer, and fall.

Reproduction and Demography.—Nothing is known about mating behavior or the mating system of Fresno kangaroo rats in the wild. Culbertson (1946) recorded observations of captive Fresno kangaroo rats, including young born in captivity, and Eisenberg (1963) and Eisenberg and Isaac (1963) described mating behavior and care of young in a captive colony of short-nosed kangaroo rats. Mating probably takes place on the surface within the territory of the female. Culbertson (1946) did not locate nests in excavated burrow systems and wrote that captive, pregnant females usually did not make nests before giving birth. He thought that this was because they were greatly disturbed by capture and confinement shortly before giving birth.

Sexual maturity was attained in as little as 82 days after birth. Pregnant female Fresno kangaroo rats have been taken between February and March and June and September (Hoffmann 1974). Pregnancies between June and September might represent second or third litters for adult females, summer breeding by young females born in the spring, or both. Females are probably capable of breeding two or more times per year.

Breeding probably is initiated in winter after onset of the rainy season. Nothing is known about pair bonds in wild populations, but there probably are no lasting male-female pair bonds formed. Females may breed with more than one male during a breeding cycle, though typically a single male attains dominance for mating purposes with one or more females within his territory, as is true of closely related kangaroo rat species. Most females born the previous season probably do not give birth until mid-February or early March during years with average or below average rainfall. In captivity, gestation was 32 days and young were weaned at 21 to 24 days. Average litter size in captive Fresno kangaroo rats was about two (range, one to three) (Culbertson 1946, Eisenberg and Issac 1963).

Young are born in the burrow, probably within a nest of dried, shredded vegetation. Young remain continuously in the burrow until they are fully furred and able to move about easily. Culbertson (1946) believed that young Fresno kangaroo rats were not found out of the burrow and foraging for themselves until about 6 weeks old. This is consistent for estimates for Tipton and short-nosed kangaroo rats (D.F. Williams, unpubl. data).

Based on limited information, populations of Fresno kangaroo rats probably turn over annually with most individuals born in the spring or summer not surviving to breed the following spring (Hoffmann 1974, Williams et al. 1993*b*, D.F. Williams unpubl. data). In the only study of Fresno kangaroo rats, Hoffmann (1974) found that only 2 of 75 marked animals were present on study plots through four trapping periods between 10 February and 28 December. Numbers were lowest in April, prior to dispersal of spring-born young, and peaked in May. By June, juveniles comprised the majority of the population. Maximum longevity in natural populations is probably between 3 to 5 years, based on studies of short-nosed kangaroo rats (Williams et al. 1993*b*).

Reproductive potential of Fresno kangaroo rats is relatively low compared to most rodents. Limiting factors on populations are unknown, but availability of suitable sites for burrows, free from winter flooding, probably is a major factor. No specific information is available on limitations of food. Likewise, there is no information on the roles of disease and predation in the population dynamics of Fresno kangaroo rats. Under current conditions of small, isolated and potentially inbred populations, both disease and predation are major threats.

Home range size varies by habitat features, season, and sex. Warner (1976) found home ranges to be small overall at an average of about 566 square meters (677 square yards) at the Alkali Sink Ecological Reserve. Warner's data may underestimate the typical home range size based on reports of other kangaroo rats. For example, in the closely related species, *D. merriami*, size of home range averaged about 1.65 hectares (16,500 square meters, 4.06 acres) for males and 1.57 hectares (15,780 square meters, 3.9 acres) for females in a study in New Mexico (Blair 1943).

In one study, estimates of population densities varied from about 16.7 to 24.8 Fresno kangaroo rats per hectare (6.8 to 10.1 per acre) during a period from February through December (Hoffmann 1974). Other studies estimated densities from 2 to 29.3 Fresno kangaroo rats per hectare (0.8 to 11.9 per acre) at different sites and in different seasons (Warner 1976, Koos 1977, 1979). Hoffmann (1974) believed that competition with Heermann's kangaroo rat, a larger, more widely-distributed species that uses a broader range of plant communities, might be an important factor in elimination of Fresno kangaroo rats from sites impacted heavily by grazing.

Behavior and Species Interactions.—Fresno kangaroo rats shelter in ground burrows that are dug by them or their predecessors. Burrows usually are found in relatively light, crumbly soils in raised areas. The surface area covered by the burrow system of individual Fresno kangaroo rats generally varies from about 2.1 to 3.7 meters (7 to 12 feet) on a side. There are usually two to five burrow entrances that slant gently underground, and one or more holes that open from a vertical shaft. Tunnels are about 51 millimeters (2 inches) in diameter and extend about 30.5 to 38.1 centimeters (12 to 15 inches) below ground. There may be several interconnecting tunnels and numerous dead-end side branches. Nesting material or large food caches have not been found in the few burrows that have been excavated (Culbertson 1946).

The burrow system is the apparent focus of territoriality in San Joaquin kangaroo rats. Except for young associated with females, each burrow system is typically occupied by a single individual. Culbertson (1946) found that captive Fresno kangaroo rats always fought when placed together in a small cage, and concluded that individuals were intolerant of each other. Yet when given sufficient space, individuals in a captive breeding colony of short-nosed kangaroo rats were more tolerant of others than expected from the typical behaviors of other species (Eisenberg 1963, Eisenberg and Isaac 1963). The social relations of Fresno kangaroo rats in the wild are unknown.

Activity Cycles.— Fresno kangaroo rats are nocturnal and active year round. They do not hibernate and cannot recover unaided from hypothermia. Tappe (1941) reported seeing Tipton kangaroo rats emerge from their burrows and begin above-ground activities as early as seven minutes before sunset in early spring. Other kangaroo rats in the San Joaquin Valley are sometimes seen above ground by day in March and April (D.F. Williams unpubl. observ.), but this is considered to be rare and isolated deviations from the typical nocturnal activity. In one study, the peak period of capture of Fresno kangaroo rats occurred later after dark than that of the larger, more aggressive Heermann's kangaroo rats (Hoffman 1985).

Habitat and Community Associations.—Fresno kangaroo rats occupy sands and saline sandy soils in chenopod scrub and annual grassland communities on the Valley floor. Recently they have been found only in alkali sink communities between 61 to 91 meters (200 to 300 feet) in elevation. Topography is often nearly level, consisting of bare alkaline clay-based soils subject to seasonal inundation and are broken by slightly rising mounds of more crumbly soils, which often accumulate around shrubs or grasses. Associated plant species include seepweed, iodine bush, saltbushes, peppergrass, filaree, wild oats, and mouse-tail fescue (Culbertson 1946, Hoffmann 1974, Hoffman and Chesemore 1982).

Within the alkali-sink plant associations, Fresno kangaroo rats probably were the most numerous small mammal under natural conditions, based on observations of the *D. nitratoides* population in an alkali sink community in the South Grasslands area of Merced County (Endangered Species Recovery Program unpubl. observ.). As such, they were a keystone species, providing a major source of food for a variety of predators, including the endangered San Joaquin kit fox. Their burrows were used extensively by the endangered blunt-nosed leopard lizard and other reptiles (Culbertson 1946, Williams 1985). Their seed-caching behaviors may have been important in the dispersal and germination of some plants, and their burrowing and digging probably beneficially affected soil structure and fertility (Williams 1985).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—When the Fresno kangaroo rat was discovered in 1891, cultivation of its habitat already was threatening the species' existence (Merriam 1894). By the early 1900s, it was believed to be extinct (Grinnell 1920), only to be rediscovered in 1933 (Culbertson 1934). By 1974, known habitat for these animals had been reduced and fragmented into three major areas, encompassing approximately 5,920 hectares (14,629 acres) in Fresno County, primarily by agricultural developments, urbanization, and transportation infrastructures (Knapp 1975). With the exception of the Alkali Sink Ecological Reserve and adjacent private land, Hoffman and Chesemore (1982) reported that only 2,396 hectares (5,920 acres) of potentially suitable habitat remained in Fresno County. Of this total, they considered 2,072 hectares (5,120 acres) to be marginal because of heavy livestock grazing. Actual presence of Fresno kangaroo rats was not confirmed on any of the nine isolated parcels composing this total.

Threats to Survival.—In spring of 1986 a levee on the south side of the San Joaquin River broke, flooding the Alkali Sink Ecological Reserve and other important habitat. Water nearly a meter deep covered most of the area for several days.

The Alkali Sink and Kerman Ecological Reserves have not been actively managed since they were purchased as habitat for Fresno kangaroo rats and other species of the Alkali Sink communities. Livestock grazing that occurred prior to acquisition by CDFG was suspended after purchase, and some parcels now have heavy growths of herbaceous plants and deep mulch cover. The change in land use from grazing to no grazing may have been a factor in the apparent elimination and possible extinction of the Fresno kangaroo rats at the Alkali Sink Ecological Reserve. Yet, conclusive data on effects of livestock grazing on habitat quality for Fresno kangaroo rats is lacking. It is likely that seasonal grazing at levels considered good range-management have a beneficial effect on habitat quality for *D. nitratoides*.

Loss of habitat to cultivation, year-round grazing (which typically requires supplemental feeding), and conversion of land to other uses continue to diminish the size and quality of extant, historical habitat. Coupled with the resulting fragmentation and isolation of habitat, these developments increase the probability of extinction. Flooding poses a high risk to protected habitat in Fresno County because of its proximity to the San Joaquin River and because this land is the same or only slightly higher in elevation than the riverbed. If a population of Fresno kangaroo rats still is extant in the area, another break in the river levee could cause its extinction. Other potential threats are the illegal use of rodenticides, competition with Heermann's kangaroo rats, and disease and predation, any of which could eliminate small, isolated populations (Williams and Germano 1993).

5. Conservation Efforts

The Fresno kangaroo rat was listed by the State of California as Rare on June 27, 1971 (Title 14, Calif. Admin. Code, Sec. 670.5). It was subsequently changed by the State to Endangered status on October 2, 1980 (Title 14, Calif. Admin. Code, Sec. 670.5). The Fresno kangaroo rat was designated as a federally-listed endangered species on 30 January 1985 (Table 1; USFWS 1985*b*).

Accompanying the listing of the Fresno kangaroo rat as endangered was the designation of 347 hectares (857 acres) as critical habitat. In 1985, when it was designated as critical habitat, 9.3 hectares (23 acres) were a small part of the 4,343-hectare (10,732-acre) Mendota Wildlife Area, and 296 hectares (732 acres) comprised the contiguous Alkali Sink Ecological Reserve, both State-owned and managed. The remaining 41.3 hectares (102 acres) of critical habitat were in five privately-owned parcels (Figure 44). Critical habitat is defined as specific areas within and outside the geographic area occupied by a species at the time of Federal listing on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection.

Concern centering around the continued loss of extant natural communities within the geographic range of the Fresno kangaroo rat precipitated State listing and subsequent studies on the life history, distribution, and threats to remaining populations (Hoffmann 1974, Knapp 1975, Koos 1977, Hoffmann and Chesemore 1982). The State Wildlife Conservation Board began acquiring habitat in 1978 in the vicinity of Whitesbridge Road (Fresno County) for establishment of the Alkali Sink Ecological Reserve. The primary purpose of these acquisitions was protection of State-listed species and alkali sink communities. Between 1978 and 1985, the State purchased approximately 377 hectares (931.7 acres) at a cost of about $1.32 million (J. Gustafson pers. comm.). Another 1.3 hectares (3.3 acres) of previously cultivated land were added later to the Alkali Sink Ecological Reserve, making its current size 382.4 hectares (945 acres). Acquisitions to date include approximately 85 percent of the designated 347 hectares (857 acres) of critical habitat for the Fresno kangaroo rat. Remaining critical habitat outside of the Alkali Sink Ecological Reserve encompasses approximately 16.2 hectares (40 acres) in three separate parcels under private ownership in NE 1/4 NW 1/4 of Sec. 12, and 25 hectares (61.8 acres) in two separate privately owned parcels and approximately 9.3 hectares (23 acres) of State-owned lands in adjacent T14S, R15E, Sec. 11. This latter State parcel is a portion of the Mendota Wildlife Area, which is principally wetland waterfowl habitat subject to regular flooding.

The CDFG developed a draft management plan for the Alkali Sink Ecological Reserve in 1984 (finalized in 1990) (CDFG in litt. 1984). Management objectives were to be the protection of native alkali sink communities and the Reserve's listed biota. Measures addressed in this draft plan included controlling grazing, fencing of reserve boundaries, encouraging maintenance of native species, restricting collecting and hunting, and precluding any development.

Williams reported in 1989 (in litt.) that management objectives for the Reserve had not been met and significant harm to the population had occurred.

USFWS prepared a Land Protection Plan for securing habitat for Fresno kangaroo rats through conservation easement or purchase (USFWS 1985*b*). The Land Protection Plan specified protection of 1,066 hectares (2,635 acres) of lands contiguous to critical habitat for Fresno kangaroo rats, along the northern border of the Alkali Sink Ecological Reserve. This plan was never implemented.

In 1988, additional inventory work was undertaken for Fresno kangaroo rats on natural lands in Merced, Madera, and Fresno Counties. Additional sites in the South Grasslands Waterfowl Management Area of Merced County were found to be inhabited by this species, but its subspecific classification is uncertain. Lack of access to private lands hampered thorough inventories elsewhere, but no Fresno kangaroo rats were found on any parcels in Fresno County that had extant

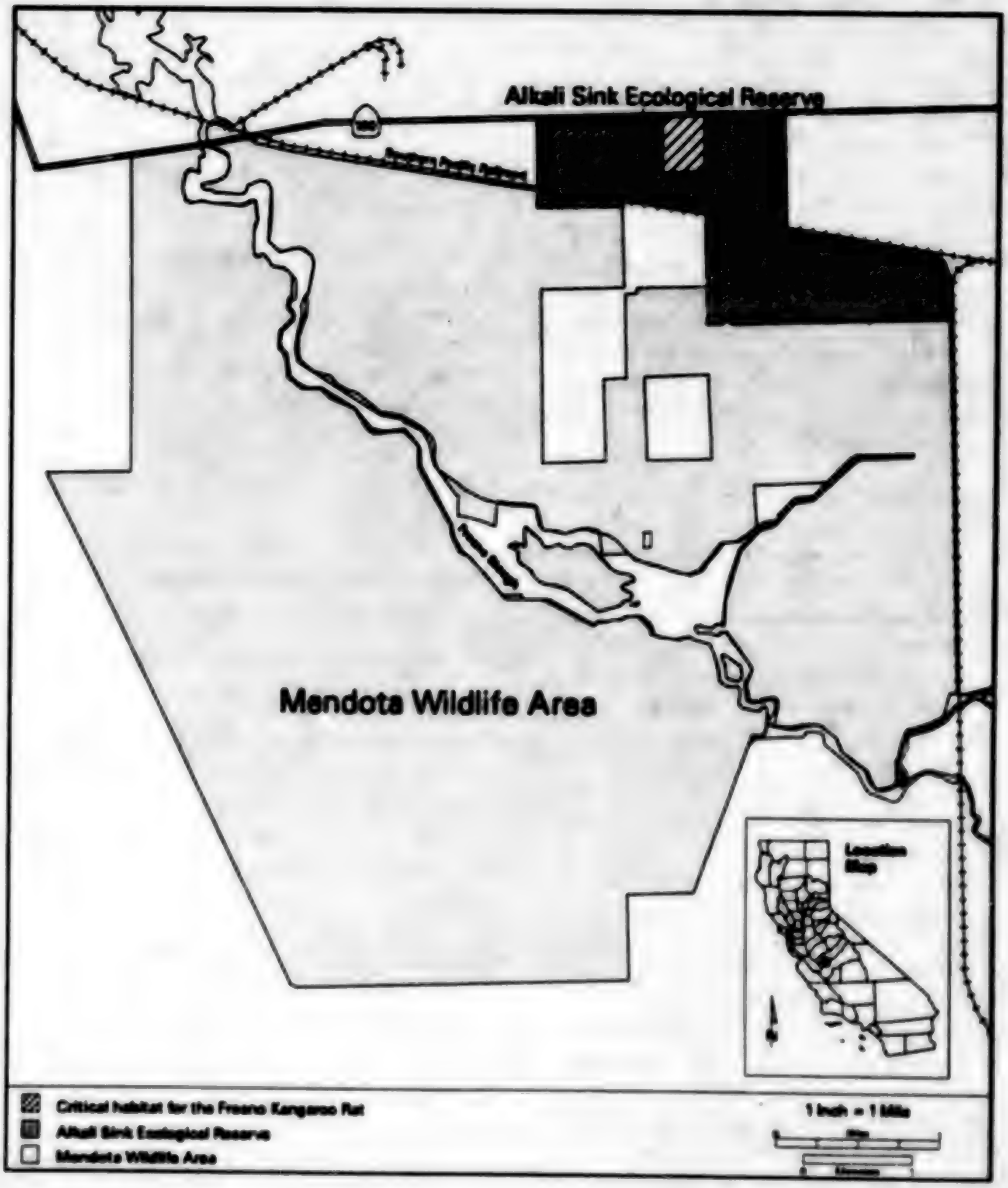
Alkali Sink Ecological Reserve
180
Southern Pacific Railroad
Fresno Slough
Mendota Wildlife Area
Location Map
▨ Critical habitat for the Fresno Kangaroo Rat
■ Alkali Sink Ecological Reserve
☐ Mendota Wildlife Area
1 Inch = 1 Mile

Figure 44. Designated critical habitat for the Fresno kangaroo rat.

populations in the 1970s and early 1980s. Attempts to locate Fresno kangaroo rats continued periodically in 1989, 1990, and 1991 without success (D.F. Williams unpubl. data).

In the *Biological Opinion for the Friant Division Water Contract Renewals*, habitat for the Fresno kangaroo rat was ranked highest in priority for protection by the Bureau of Reclamation (USFWS in litt. 1991). Before that could be accomplished, however, extant populations had to be located. Attempts to identify and inventory all potential habitat for Fresno kangaroo rats within their historical range, began in September 1992 and are continuing today. This effort was successful in finding only a single Fresno kangaroo rat, a male, on land already in State ownership. The Bureau of Reclamation also has funded a study of the population genetics and taxonomy of San Joaquin kangaroo rats. Principal objectives are to determine the range-wide genetic structure of the species and the degrees of differentiation of the various fragmented populations (Patton in litt. 1994). This work still is in progress.

The Endangered Species Recovery Program continued the search for extant populations of Fresno kangaroo rats and initiated management studies of kangaroo rats on the Kerman and Alkali Sink Ecological Reserves. Because there apparently are no extant populations on these reserves, the initial objectives are to measure population sizes of Heermann's kangaroo rats and vegetation characteristics on four plots, two on each Reserve. If future funds are provided, grazing could be initiated in future years and vegetation and population responses of Heermann's kangaroo rats measured. The goal would be to find a vegetation management regime that reduces populations of Heermann's kangaroo rats. Population responses to both grazing and burning are being tested in habitat for a small population of *D. nitratoides* on Lemoore Naval Air Station, funded by the Navy and conducted by the Endangered Species Recovery Program. Additional population and vegetation management studies on Pixley National Wildlife Refuge, directed at determining appropriate habitat management for Tipton kangaroo rats, are expected to provide some information needed to manage habitat for Fresno kangaroo rats. This strategy assumes that Fresno kangaroo rats will be available for translocation to the Alkali Sink and Kerman Ecological Reserves. This will require that a population be located or that one or more of the extant populations peripheral to the historical range of the Fresno kangaroo rat prove to be genetically and taxonomically inseparable from Fresno kangaroo rats (Williams and Kelly in litt. 1994*b*, 1994*c*).

U.S. Environmental Protection Agency County bulletins governing use of rodenticides have greatly reduced the risk of significant mortality to Fresno kangaroo rat populations by State and county rodent-control activities. The California Environmental Protection Agency, California Department of Food and Agriculture, county agricultural departments, CDFG, and the U.S. Environmental Protection Agency collaborated with the Service in the development of County Bulletins that both are efficacious and acceptable to land owners (R.A. Marovich pers. comm.).

6. Recovery Strategy

Several pressing issues must be attended to now concerning recovery of the Fresno kangaroo rat. Answering the questions these issues pose is an integral first step in addressing recovery:

1. The genetic relationships among extant isolated and scattered populations of San Joaquin kangaroo rats.

2. Location and size of any extant Fresno kangaroo rat populations.

3. How to manage natural lands to enhance habitat for Fresno kangaroo rats.

The second step to recovery involves instituting actions dictated by resolution of these issues, such as restoring and protecting of habitat, possibly translocating populations, and continuing management studies and population monitoring. The consolidation and protection of sufficient habitat for Fresno kangaroo rats to maintain a viable population cannot await the resolution of all these issues, though. There already is historical habitat in public ownership, though it is not sufficiently protected from catastrophes, such as flooding, nor appropriately monitored and managed for Fresno kangaroo rats. But, even with optimal habitat management, these parcels appear to be too small and vulnerable to both flooding and other catastrophes to provide the only refuges for the species. Thus, protection of the large block of natural land north of and between the Alkali Sink Ecological Reserve and the San Joaquin River and even larger blocks elsewhere is needed.

The largest existing block of natural land that was historical habitat for Fresno kangaroo rats is located in western Madera County (Williams 1990). Approximately 12,000 hectares (30,000 acres) are located in contiguous parcels. Fresno kangaroo rats still possibly exist on some part of this property, but access was given to Endangered Species Recovery Program to survey only two parcels comprising less than 10 percent of the total. Fresno kangaroo rats were not located on either parcel, though blunt-nosed leopard lizards, San Joaquin kit foxes, and palmate-bracted bird's beak were seen or known from the sites or general area (Williams 1990, D.F. Williams unpubl. data). Because this area provides the highest potential for containing an extant population of Fresno kangaroo rats, and also is an important element in the recovery of palmate-bracted bird's beak and blunt-nosed leopard lizards, protection and management of parcels there is considered of greater importance than elsewhere on parcels that are not known to be currently occupied.

The population of San Joaquin kangaroo rats at Lemoore Naval Air Station is the only one in public ownership in Kings County, and is endangered regardless of its taxonomic identity as the Fresno or Tipton kangaroo rat. Though the Navy has instituted habitat management studies on the parcel, it is too small to support a viable population indefinitely. The occupied site was formerly farmed, but then was retired to provide a motorcross track for Navy personnel. Kangaroo rats probably colonized the site by dispersing from the formerly-occupied land around a nearby runway. Restoration and enhancement of habitat next to the runway is not an option because this could attract birds and increase the probability of planes striking birds. Expansion of the existing habitat area by retiring land next to the motorcross site and managing it appropriately is important to maintaining the kangaroo rat population. Because the land is owned by the U.S. Government and is part of the air station, acquisition would not be needed, and the loss of revenue from the agricultural lease would be small compared to the cost of protecting habitat elsewhere. The amount of land needed cannot be calculated precisely now, but the initial addition of 32 to 65 hectares (80 to 160 acres) to the 38 hectares (97 acres) of existing habitat would provide space and habitat for an expanding population. The sooner this is accomplished, the greater the chances that the population can be saved.

Restoration of habitat and, if necessary, reestablishment of Fresno kangaroo rats on the Alkali Sink and Kerman Ecological Reserves also are elements of the recovery of the species, but until management issues, including protection from flooding, are resolved, these have lower priority. Reducing the accumulation of mulch and ground cover of weedy grasses has priority over other management issues on these reserves. Restoration to optimal conditions at the Kerman Reserve for Fresno kangaroo rats may also require establishment of saltbushes and other shrubs.

Size of occupied habitat areas for recovery ideally should be several thousand acres each, but no existing or potential habitat area comes near to the minimum desirable size. Therefore, criteria are scaled to size of existing and potential habitat areas. With habitat management, these parcels should be adequate to support populations. Three separate populations reduce the risk of extinction by environmental catastrophes, and considerably enhance the prospects of recovery. A larger number of separate populations is possible, but obtaining more than four large populations on public lands probably is not very practical given the amount and distribution of natural lands within the historic range of the species.

Recovery Actions.—Recognizing that genetic and taxonomic studies (Patton in litt. 1994, J.L. Patton pers. comm.) and habitat surveys already are in progress, critical recovery actions needed now are:

1. Complete the studies on relationships and taxonomic identity of isolated populations of San Joaquin kangaroo rats.

2. Intensify and continue efforts to locate populations of Fresno kangaroo rats within the historical range of the species. If a population is found, captive breeding should be considered as a recovery option depending on the size of the population.

3. Continue and increase habitat management studies.

4. Restore additional habitat for *D. nitratoides* at Lemoore Naval Air Station.

5. Protect natural land between the Alkali Sink Ecological Reserve and the San Joaquin River to the north (Sandy Mush Road/South Grasslands Area).

6. Begin discussion and planning for conservation of natural lands in western Madera County;

acquire title or easement to appropriate parcels from willing sellers.

Recovery actions that also are needed, but after critical actions are implemented or completed are:

7. Protect additional habitat for Fresno kangaroo rats in Kings County, where populations of the species are discovered. Habitat should be in blocks of at least 384 hectares (950 acres), preferably larger, with one block no less than 1,012 hectares (2,500 acres).

8. Work with landowners in western Madera County to determine presence or absence of the species there. If a population is found, assess translocating populations to public lands in Fresno County.

9. Restore habitat for Fresno kangaroo rats on the Alkali Sink and Kerman Ecological Reserves. Restoration should include manipulation of the plant community to favor Fresno kangaroo rats over Heermann's kangaroo rats.

10. Reintroduce Fresno kangaroo rats to restored and unoccupied habitats on ecological reserves and newly-protected parcels.

11. Monitor all populations and their supporting biotic communities annually for a 10-year period, then at 3-year intervals until recovery is achieved.

12. Manage habitat for Fresno kangaroo rats as needed.

J. Tipton Kangaroo Rat
(Dipodomys nitratoides nitratoides)

1. Description and Taxonomy

Taxonomy.—The Tipton kangaroo rat is one of three subspecies of the San Joaquin kangaroo rat. The type specimen of the Tipton kangaroo rat was collected from Tipton, Tulare County, California, in 1893 (Merriam 1894). See account of the Fresno kangaroo rat for a discussion of taxonomic history of *D. n. nitratoides*. Hafner (1979) examined samples of Tipton and short-nosed kangaroo rats, and, using detailed analyses, established better-defined boundaries between the two subspecies than those of previous researchers. He concluded that samples from populations northeast and east of Bakersfield, and in upland saltbush communities above the southern and eastern borders of the Tulare Basin floor were characteristic of populations of short-nosed kangaroo rats, typified by reference samples from the Carrizo Plain, San Luis Obispo County. Hafner's (1979) analyses showed that the subspecies boundary on the southwest in Kern County nearly coincided with the California Aqueduct, which is positioned just above the Valley floor along the edge of the more steeply sloping foothills in areas that do not flood extensively. The natural boundary between these two subspecies on the southwest was probably a narrow zone of seasonal and permanent wetlands around Kern and Buena Vista lakes and the Kern River channel that meandered north from the east edge of the Elk Hills to historical Goose Lake. Historical barriers between the two subspecies probably were intermittent in some spots. More recent flood control and diversion of waters from the Kern River for irrigation and other purposes removed these barriers and probably allowed for increased genetic exchange between the two subspecies. Today, the California Aqueduct and large expanses of irrigated cropland again have isolated these populations.

Description.—See account of the Fresno kangaroo rat for a general description of the species. On average, adult Tipton kangaroo rats weigh about 35 to 38 grams (1.23 to 1.34 ounces), have a head and body length of about 100 to 110 millimeters (3.94 to 4.33 inches) and a tail about 125 to 130 millimeters (4.92 to 5.12 inches) in length. The Tipton kangaroo rat is larger than the Fresno kangaroo rat and smaller than the short-nosed kangaroo rat.

Identification.—See the Fresno kangaroo rat account for distinguishing Tipton kangaroo rats from other co-occurring species. The Tipton kangaroo rat can be distinguished from the Fresno kangaroo rat by its larger average measurements: total length for males, 235 millimeters (9.25 inches), for females, 221 millimeters (8.7 inches); length of hind foot for males 34.7 millimeters (1.37 inches), for females, 33.6 millimeters (1.32 inches); mean inflation of the auditory bullae for males, 22.1 millimeters (0.87 inch), for females, 21.8 millimeters (0.86 inch) (Hoffmann 1975) (see accounts of Fresno and short-nosed subspecies for corresponding average measurements).

2. Historical and Current Distribution

Historical Distribution.— The historical geographic range of Tipton kangaroo rats (Figure 45) was estimated to cover approximately 695,174 hectares (1,716,480 acres) (Williams 1985). Tipton kangaroo rats were distributed within an area on the floor of the Tulare Basin, extending from approximately the southern margins of Tulare Lake on the north; eastward and southward approximately along the eastern edge of the Valley floor in Tulare and Kern Counties. The southern and western extent of their range was the foothills of the Tehachapi Mountains (south) and the marshes and open water of Kern and Buena Vista lakes, and the sloughs and channels of the Kern River alluvial fan. Farther north, the western boundary was approximately along the Buena Vista slough of the Kern River channel into Goose Lake. The approximate line on the northwest is marked by the city of Lost Hills, Kern County; Kettleman City, Kings County; and Westhaven, Fresno County. Prior to development of water-diversion and irrigation systems over the past several decades, this area bounded three large lakes, Tulare, Kern, and Buena Vista, together with marshlands that were unsuitable habitat for kangaroo rats (Boolootian 1954, Hoffmann 1974, Hafner 1979, Williams et al. 1993*a*, Williams 1985).

Current Distribution.—By July 1985, the area inhabited had been reduced, primarily by cultivation and urbanization, to about 25,000 hectares (63,000 acres), only about 3.7 percent of the historical acreage. Additional small parcels not surveyed by Williams (1985) have since been found to be inhabited. Tipton kangaroo rats also have reinhabited several hundred to a few thousand acres that were in crop production in 1985 but have since been retired because of drainage problems or lack of water, or acquired by State and Federal agencies for threatened and endangered species conservation. Most notable has been a mix of mostly agricultural and some natural land on the Kern Fan Element, some of which is now within the Kern Water Bank Habitat Conservation Plan area. This project provides over 4,000 hectares (10,000 acres) of habitat for threatened and endangered species, though a lesser, unknown amount actually has been naturally recolonized from adjacent natural land. Offsetting these gains has been the loss of several hundred to a few thousand acres of habitat that have been developed. Thus, the current acreage of occupied habitat is unknown, but probably does not differ much from the 1985 estimate.

Current occurrences are limited to scattered, isolated areas clustered west of Tipton, Pixley, and Earlimart, around Pixley National Wildlife Refuge, Allensworth Ecological Reserve, and Allensworth State Historical Park, Tulare County; between the Kern National Wildlife Refuge, Delano, and in natural lands surrounding Lamont (southeast of Bakersfield), Kern County; at the Coles Levee Ecosystem Preserve; and other, scattered units to the south in Kern County (Figure 45).

3. Life History and Habitat

Food and Foraging.—Tipton kangaroo rats eat mostly seeds, with small amounts of green, herbaceous vegetation and insects supplementing their diet when available. Most aspects of food and foraging of Tipton kangaroo rats are identical to those of Fresno kangaroo rats. See the account of the Fresno kangaroo rat for more information.

Reproduction and Demography.—Little specific information has been published on reproduction of Tipton kangaroo rats. Generally, this aspect of their biology is extremely similar to that of the Fresno kangaroo rat (see that account for details). Five Tipton kangaroo rats being held in captivity to prevent their death by permitted destruction of their habitats each gave birth to two young (D.J. Germano pers. comm., D.F. Williams unpubl. observ., S. Yoerg pers. comm.).

Reproduction commences in winter and peaks in late March and early April (Figure 46). Most females appear to have only a single litter, though some adult females have two or more, and females born early in the year also may breed (Endangered Species Recovery Program unpubl. data).

At the Paine Wildflower Preserve south of Kern National Wildlife Refuge, Clark et al. (1982) estimated a density of 2.6 Tipton kangaroo rats per hectare (1.05 per acre) in the "best" habitat above flood level, and 1.5 per hectare (0.61 per acre) in "poor" habitats subjected to flooding and disturbance by past disking of the soil. Hafner (1979) estimated relative densities of Tipton kangaroo rats at 13 sites representing areas from throughout the geographic range and most plant communities in which Tipton kangaroo rats were known to occur. Densities ranged from a low of 1 to 2 per hectare (0.4 to 0.8 per acre) in alkaline and terrace grasslands with a sparse cover of seepweed to a high of

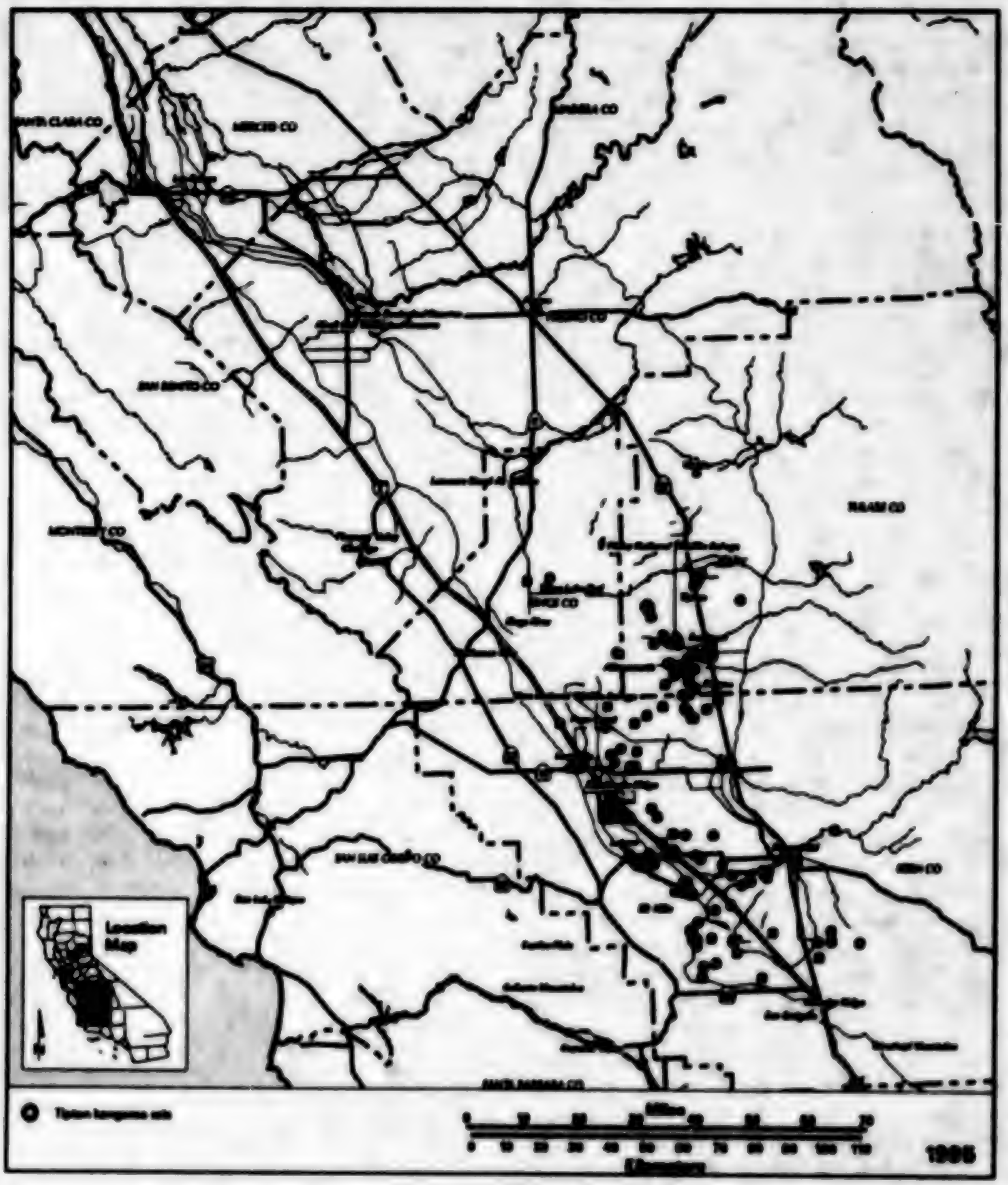

Figure 45. Distributional records for the Tipton kangaroo rat (*Dipodomys nitratoides nitratoides*).

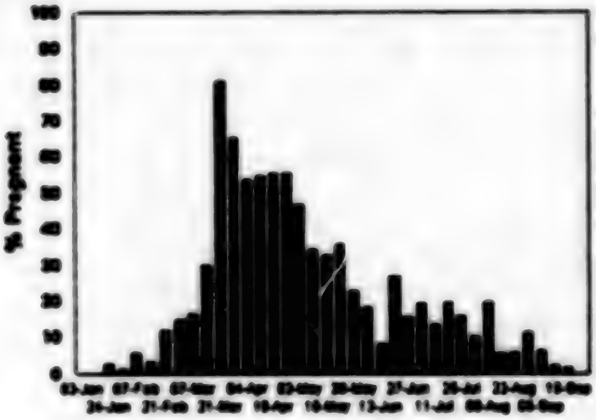

Figure 46. Percentage of reproductive female Tipton kangaroo rats. Based on weekly censuses at Pixley National Wildlife Refuge (Endangered Species Recovery Program unpubl. data); weeks 3 Jan. 1993 to 19 Sep. 1994.

about 7 to 9 per hectare (2.8 to 3.6 per acre) in saltbush scrub.

In 1985, surveys through the remaining extant habitat resulted in estimated densities, based on numbers of burrow systems, ranging from less than 1 per hectare to 50 per hectare (less than 0.4 to 20.2 per acre). Areas supporting very low densities had few noticeable features in common. Sites on the eastern perimeter of the geographic range in terrace grasslands had consistently low densities. Areas subjected to prolonged flooding also supported few kangaroo rats.

At Pixley National Wildlife Refuge on two plots, density estimates in June 1991 during drought were 3.0 to 3.8 Tipton kangaroo rats per hectare (1.2 to 1.5 per acre). After the end of a 5.5 year drought in April 1991, a population irruption occurred, and peaked in January 1993. Subsequently, density declined from the high of 88.2 per hectare (35.7 per acre) in January 1993 to a low of 1.1 per hectare (0.45 per acre) in April 1995. The shape of this population decline is illustrated by the number of Tipton kangaroo rats known to be alive each month in Figure 47 (Endangered Species Recovery Program unpubl. data). During the decline, annual rainfall was greater than average and little or no livestock grazing occurred in the pasture where the plot was located. Kangaroo rats could not use their usual defenses of speed and alertness, adaptations for habitats with sparse, low vegetation, and many may have been taken by predators. High rainfall also may have caused death from water penetrating burrows and drowning occupants, spoiling seed stores, or causing death from hypothermia or pneumonia-like diseases that have been observed to afflict these animals when placed in a cool, moist environment (Endangered Species Recovery Program unpubl. observ.).

Behavior and Species Interactions.—Tipton kangaroo rats live in ground burrows. Most burrows probably are dug by the occupant or a predecessor of the same species. Burrows are typically simple, but may be unbranched or branched, including interconnecting tunnels. Most burrows are less than 25 centimeters (10 inches) deep (Germano and Rhodehamel 1995). Nothing else specific to the behavior of the Tipton subspecies has been published (see Fresno kangaroo rat for a general discussion of behavior and species interactions).

Tipton kangaroo rats are food for a variety of predators: coyotes, San Joaquin kit foxes, long-tailed weasels, American badgers, owls, hawks (San Joaquin kangaroo rats infrequently emerge from their burrows during daylight; Tappe 1941, Williams et al. 1993*b*), various species of snakes, and probably others. Except for small, isolated populations, predation is unlikely to threaten Tipton kangaroo rats. The increasing fragmentation of the range of Tipton kangaroo rats, however, increases the vulnerability of small populations to predation.

Habitat and Community Associations.—Tipton kangaroo rats are limited to arid-land communities occupying the Valley floor of the Tulare Basin in level or

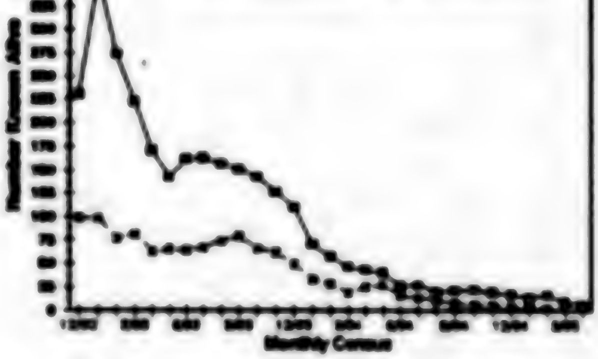

Figure 47. Number of Tipton kangaroo rats known to be alive each month. Endangered Species Recovery Program data are for plot at Pixley National Wildlife Refuge.

nearly level terrain. They occupy alluvial fan and floodplain soils ranging from fine sands to clay-sized particles with high salinity. Historically, populations apparently were most numerous and persistent in Relictual Interior Dune Grassland and Sierra-Tehachapi Saltbush Scrub communities. Today, much of the occupied remnants of their range have one or more species of sparsely scattered woody shrubs and a ground cover of mostly introduced and native annual grasses and forbs. Woody shrubs commonly associated with Tipton kangaroo rats are: spiny and common saltbushes, arrowscale (*Atriplex phyllostegia*), quailbush (*Atriplex lentiformis*), iodine bush, pale-leaf goldenbush, and honey mesquite (*Prosopis glandulosa* var. *torreyana*). A conspicuous semiwoody species is seepweed (Williams 1985).

Important existing communities for Tipton kangaroo rats are iodine bush shrubland (Valley Sink Scrub) and Valley Saltbush Scrub (Griggs et al. 1992). Winter rains and runoff from the surrounding mountain ranges (Sierra Nevada to the east, Tehachapi Mountains to the south, and Temblor Range to the west) flood much of these low-lying communities occupied by Tipton kangaroo rats. Areas with standing water during portions of winter and spring (vernal pools) become alkaline playas when the water has evaporated allowing Tipton kangaroo rats to recolonize these areas even though alkaline water lies close to the surface of the soil, year around. Presumably during flooding, individuals are either drowned or captured by predators after being forced from their burrows, or escape to higher ground (Williams 1985).

Although Tipton kangaroo rats occur in terrace grasslands devoid of woody shrubs, sparse-to-moderate shrub cover is associated with populations of high density. Typically, however, burrow systems are located in open areas; only in areas of dense shrub cover are burrows usually located beneath shrubs. Terrain not subject to flooding is important for permanent occupancy by Tipton kangaroo rats.

Burrows of Tipton kangaroo rats are commonly located in slightly elevated mounds, the berms of roads (where placed above ground level), canal embankments, railroad beds, and bases of shrubs and fences where windblown soils accumulate above the level of surrounding terrain. Soft soils, such as fine sands and sandy loams, and powdery soils of finer texture and of higher salinity are generally associated with greater densities of Tipton kangaroo rats than are less saline and alkaline, sandy-loam, loam, and clay-loam soils of portions of the eastern margins of their geographic range, supporting terrace grasslands. This may relate to how crumbly the soils are, the type of plant communities they support, or both (Williams 1985).

At Pixley National Wildlife Refuge, Tipton kangaroo rats are the most numerous small mammal. They dominate grazed annual grassland on the refuge, where they typically outnumber Heermann's kangaroo rats, the second most numerous species. Other common, small mammalian associates are San Joaquin pocket mice and deer mice (Williams and Germano 1991, D.F. Williams unpubl. data). Other common, mammalian associates include San Joaquin kit foxes, coyotes, American badgers, California black-tailed hares, California ground squirrels, harvest mice, and house mice.

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—The principle reason for the decline of Tipton kangaroo rats was the loss of habitat due to agricultural conversion. Agriculture followed the gold rush of the 1850s, first developing on the nonsaline soils of the alluvial flood plains and forests of the eastern Valley. This probably only had a minor impact to habitat for Tipton kangaroo rats. The later construction of dams and canals produced a dependable supply of water for the Valley. This in turn allowed the cultivation of the alkaline soils of the saltbush and valley sink scrub and relictual dune communities, and was principally responsible for the decline and endangerment of the Tipton kangaroo rat.

As recently as the early 1970s, just after the completion of the Central Valley and State Water Projects, only about 1.4 million hectares (3.5 million acres) in the San Joaquin Valley were in irrigated cultivation—most of the total was in the San Joaquin Basin (approximately the northern half of the Valley). By 1978, however, only about 195,000 hectares (370,000 acres) out of a total of about 3.4 million hectares (8.5 million acres) on the San Joaquin Valley floor remained as non-developed land (Williams 1985).

An aerial survey conducted in late 1983, together with selected ground inspections and other sources of information provided an estimate of 44,562 hectares (110,031 acres) of undeveloped land out of a total of 1,035,296 hectares (2,556,288 acres) on the floor of the Tulare Basin (Werschkull et al. 1984). Ignoring minor differences between the boundaries of the 1983 survey and the investigations by Williams (1985), only about 30,549 hectares (75,430 acres) were undeveloped in June 1985. Remaining natural lands represented the least desirable for development in the basin.

The use of rodenticides to control California ground squirrels probably contributed to the decline or elimination of small populations of Tipton kangaroo rats, isolated and surrounded by agricultural land. Urban and industrial development and petroleum extraction all have contributed to habitat destruction, though not on a scale comparable to agricultural development (Williams 1985).

Threats to Survival.—Current threats of habitat destruction or modifications rendering areas unsuitable for Tipton kangaroo rats come from industrial and agriculturally-related developments, cultivation, the formation of heavy thatch by exotic grasses, and urbanization, and secondarily from flooding. Nearly every parcel of land in private ownership that is currently inhabited by Tipton kangaroo rats is surrounded by cultivated fields or urbanized land where these animals cannot live. Nearly all remaining natural land is of poor agricultural potential, having saline soils and high water tables, and more than half is subject to winter flooding (Williams 1985).

Because of the large amount of salts in soils on the Tulare Basin floor, lack of natural drainage to the ocean, and the desert climate, build up of salts in the soil and saline-saturated fields threatens agriculture over large areas (San Joaquin Valley Interagency Drainage Program 1990). Most of the remaining habitat of Tipton kangaroo rats is in areas that are already flooded periodically. Several parcels with extant natural lands in the 1970s now have private evaporation ponds into which salt-laden drain waters are being diverted. Unless other solutions are found for drainage problems, including land retirement, more habitat for Tipton kangaroo rats probably will be lost to this purpose (Williams 1985).

5. Conservation Efforts

In addition to being federally-listed as endangered in 1988 (USFWS 1988), the Tipton kangaroo rat was listed by the State of California as Endangered in 1989 (Table 1; Williams and Kilburn 1992). Mitigation actions and compensation funds to purchase natural lands providing habitat for Tipton kangaroo rats have resulted in preservation of portions of key areas in the Allensworth Ecological Reserve, Semitropic Ridge, Kern Fan areas, and more scattered parcels elsewhere (Table 2).

Habitat management studies on Pixley National Wildlife Refuge, which provides some of the best remaining habitat for Tipton kangaroo rats, were initiated in 1991 (Williams and Germano 1991), and expanded in 1992 (Engler and Chapin 1993). The CDFG also has begun to census its properties and investigate habitat management in the Allensworth Ecological Reserve (Potter 1993). The Bureau of Reclamation and USFWS have supported a study of population ecology of Tipton kangaroo rats at Pixley National Wildlife Refuge by the Endangered Species Recovery Program since December 1992 (Endangered Species Recovery Program unpubl. information). CDFG also has recently instituted habitat management investigations and experimentation on part of Allensworth Ecological Reserve (M. Potter and G. Presley pers. comm.).

U.S. Environmental Protection Agency County bulletins governing use of rodenticides have greatly reduced the risk of significant mortality to Tipton kangaroo rat populations by State and county rodent-control activities. The California Environmental Protection Agency, California Department of Food and Agriculture, county agricultural departments, CDFG, and the U.S. Environmental Protection Agency collaborated with the Service in the development of County Bulletins that both are efficacious and acceptable to land owners (R.A. Marovich pers. comm.).

6. Recovery Strategy

The major issues in recovering the Tipton kangaroo rat are habitat management and protection of blocks of their natural or restored habitat to maintain viable populations. The species' populations periodically irrupt to high levels and decline rapidly, often going extinct locally. Local extinctions or near extinctions may be caused by long-term drought, excessive amounts of precipitation, flooding, and perhaps other, less well known factors. When large expanses of connected habitat existed, local extinction was not a great problem because some surviving populations eventually irrupted and individuals recolonized areas where they had been eliminated. Contributing to this pattern of population dynamics is competition with Heermann's kangaroo rats, which are much larger, more general in their habitat requirements, and more successful in maintaining populations in a fragmented landscape. At times when the environment is poorly suited to Tipton kangaroo rats, competition with Heermann's kangaroo rats may cause elimination of the former. Because of the fragmentation and isolation of remaining habitat, when these natural processes ensue, local extinction without opportunity for later recolonization results. This process already has run or nearly run its course with Fresno kangaroo rats. There are several blocks of habitat for Fresno kangaroo rats left, ranging from about 16.2 hectares (40 acres) to several from about 259 to 2,023 hectares (640 to 5,000 acres), and one of about 12,141 hectares (30,000 acres), yet none are known to harbor Fresno kangaroo rats. Because the decline and fragmentation of Tipton kangaroo rat habitat has occurred much more recently, probably a similar fate awaits it unless there is management intervention, and conservation lands for this species are sufficiently large and diverse to reduce or eliminate the adverse effects of same environmental processes. Thus, the two key elements of a recovery strategy for Tipton kangaroo rats are:

1. Determining how to manage natural lands to enhance habitat for Tipton kangaroo rats that lessens the frequency and severity of population crashes and negative impact of competition with Heermann's kangaroo rats.

2. Consolidating and protecting blocks of suitable habitat for Tipton kangaroo rats to minimize the effects of random catastrophic events (e.g., drought, flooding, fire) on their populations.

These blocks should be of several thousand acres each with a core of at least 2,000 hectares (about 5,000 acres) of high quality habitat that is not subject to periodic flooding from overflowing streams or sheet flooding from torrential rain. They should provide topographic diversity and diversity of plant communities. The vegetation should be actively managed by an appropriate level of livestock grazing to prevent excessive accumulation of mulch and growing plants until such time as optimum management conditions are determined by scientific research.

The existing configuration of the natural land-developed land mosaic is such that it is impractical and too expensive to propose reconnecting the large blocks of land in Tulare and northern Kern and southern Kings Counties with the lands on the western edge of the Valley and the isolated blocks in the southern end of the Valley. Instead, by protection of additional natural land and restoration of contiguous agricultural land with drainage problems, sufficient habitat in three areas can be protected economically: the Kern Fan area; the Pixley National Wildlife Refuge-Allensworth Natural Area, and the Kern National Wildlife Refuge-Semitropic Ridge area.

Recovery Actions.—Needed recovery actions are:

1. Expand, coordinate, and continue habitat management studies of Tipton kangaroo rats at sites representing the range of existing habitat conditions for the species.

2. Initiate studies of competition between Tipton and Heermann's kangaroo rats, focusing primarily on how different habitat management prescriptions affect the population dynamics of the two species at sites of coexistence.

3. Design and implement a range-wide population monitoring program that measures population and environmental fluctuations at sites representative of the range of natural land sizes and habitat conditions for the species.

4. Inventory and assess existing natural land and drainage-problem parcels contiguous to and near existing protected natural lands and develop a protection plan that ranks parcels that may be available according to their size and potential for supporting Tipton kangaroo rats, with the objective of connecting and expanding:

    a. Pixley National Wildlife Refuge and the scattered parcels of the Allensworth Ecological Reserve;

    b. Kern National Wildlife Refuge and the scattered parcels of the Semitropic Ridge conservation lands;

    c. Kern River alluvial fan area including the Kern Fan Element, Cole's Levee Ecosystem Preserve, and other mitigation parcels.

    d. Additional lands which after inventory and assessment are identified as important to the two key elements of the recovery strategy for Tipton kangaroo rats.

5. Develop and implement research on restoration of habitat for Tipton kangaroo rats, including cost-effective mechanisms to protect both natural and restored habitat from flooding.

6. Restore habitat on retired agricultural lands as needed.

K. Blunt-Nosed Leopard Lizard
(*Gambelia sila*)

1. Description and Taxonomy

Taxonomy.—The blunt-nosed leopard lizard was described and named by Stejneger (1890) as *Crotaphytus silus*, from a specimen collected in Fresno, California. Cope (1900), however, considered the blunt-nosed leopard lizard to be a subspecies of the long-nosed leopard lizard (*C. wislizenii*), and listed it as *C. w. silus*. Under this arrangement, leopard lizards and collared lizards were placed in the same genus. Smith (1946) separated the collared from the leopard lizards, placing the latter in the genus *Gambelia*. The bases for separation were differences in head shape, presence or absence of *gular* (throat area) folds, and differences in bony plates on the head. The subspecific status of *G. w. silus* was retained by Smith (1946). This generic split was not universally agreed upon and the status, both generic and specific, of the lizards remained controversial until Montanucci (1970) presented a solid argument for specific status based upon the study of hybrids between the long-nosed and blunt-nosed leopard lizards. Montanucci et al. (1975) again separated *Gambelia* from *Crotaphytus*, resulting in the name *Gambelia silus* (Jennings 1987). Frost and Collins (1988), Collins (1990), and Germano and Williams (1993) used the spelling *sila* to properly agree in gender with the genus *Gambelia*.

Description.—The blunt-nosed leopard lizard (Figure 48) is a relatively large lizard of the family Iguanidae, with a long, regenerative tail; long, powerful hind limbs; and a short, blunt snout (Smith 1946, Stebbins 1985). Adult males are larger than adult females, ranging in size from 87 to 120 millimeters (3.4 to 4.7 inches) snout-vent length (Tollestrup 1982). From snout to vent, females are 86 to 111 millimeters long (3.4 to 4.4 inches). Adult males weigh between 31.8 and 37.4 grams (1.3 to 1.5 ounces), and adult females weigh between 20.6 and 29.3 grams (0.8 to 1.2 ounces) (Uptain et al. 1985). Males are distinguished from females by their enlarged postanal scales, femoral pores (visible pores on the underside of the thigh), temporal and mandibular muscles (muscles on the skull that close the jaws), and tail base (Montanucci 1965).

Although blunt-nosed leopard lizards are darker than other leopard lizards, they exhibit tremendous variation in color and pattern on the back (Tanner and Banta 1963, Montanucci 1965, 1970). Background color ranges from yellowish or light gray-brown to dark brown depending on the surrounding soil color and vegetation association (Smith 1946, Montanucci 1965, 1970, Stebbins 1985). The under surface is uniformly white.

The color pattern on the back consists of longitudinal rows of dark spots interrupted by a series of from 7 to 10 white, cream-colored, or yellow transverse bands. In the blunt-nosed leopard lizard, the cross bands are much broader and more distinct than in other leopard lizards and extend from the lateral folds on each side to the middle of the back, where they meet or alternate along the midline of the back. With increasing age the cross bands may fade and the spots may become smaller and more numerous, particularly in males (Montanucci 1967, Smith 1946). Similarly colored bands or rows of transverse spots produce a banded appearance to the tail (Smith 1946). Juveniles have blood-red spots on the back that darken with age, becoming brown when sexual maturity is reached, although a few adults retain reddish centers to the spots (Montanucci 1967).

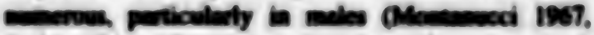

Figure 48. Illustration of a blunt-nosed leopard lizard. Drawing by Kristina Bocchini (© by CSU Stanislaus Foundation).

Except for the throat, undersides are uniformly white to yellow in immature lizards and prenuptial females. Nuptial females have bright red-orange markings on the sides of the head and body and the undersides of the thighs and tail. This color fades to pink or light orange by late July. Males in many populations develop a nuptial color during the breeding season that spreads over the entire undersides of the body and limbs. This salmon to bright rusty-red color may be maintained indefinitely (Montanucci 1965).

Identification.—The blunt-nosed leopard lizard can be distinguished from the long-nosed leopard lizard by its color pattern, truncated snout, and short, broad triangular head (Stejneger 1890, Smith 1946). The blunt-nosed leopard lizard has dark blotches on the throat instead of parallel streaks of the long-nosed leopard lizard. Other distinguishing characteristics are a significantly smaller number of maxillary and premaxillary teeth (this may be directly related to the shortened snout) and a smaller variation in the number of femoral pores (Smith 1946). In general, blunt-nosed leopard lizards can be distinguished from all other leopard lizards by their retention into adulthood of the primitive color pattern shared by all young leopard lizards (absence of ornamentation around the dorsal spots; retention of wide, distinct cross bands; presence of gular blotches; and fewer spots arranged in longitudinal rows) (Smith 1946, Montanucci 1970).

2. Historical and Current Distribution

Historical Distribution.—The blunt-nosed leopard lizard is endemic to the San Joaquin Valley of central California (Stejneger 1893, Smith 1946, Montanucci 1965, 1970, Tollestrup 1979*a*). Although the boundaries of its original distribution are uncertain, blunt-nosed leopard lizards probably occurred from Stanislaus County in the north, southward to the Tehachapi Mountains in Kern County (Figure 49). Except where their range extends into the Carrizo Plain and Cuyama Valley west of the southwestern end of the San Joaquin Valley, the foothills of the Sierra Nevada and Coast Range Mountains, respectively, define the eastern and western boundaries of its distribution. The blunt-nosed leopard lizard is not found above 800 meters (2,600 feet) in elevation (Montanucci 1970). The blunt-nosed leopard lizard hybridizes with the long-nosed leopard lizard where their ranges meet in Ballinger Canyon and others (Santa Barbara and Ventura Counties) in the Cuyama River watershed (Montanucci 1970, Le Fevre in litt. 1976).

Current Distribution.—Although the blunt-nosed leopard lizard has been listed as endangered for 30 years, there has never been a comprehensive survey of its entire historical range. The currently known occupied range of the blunt-nosed leopard lizard is in scattered parcels of undeveloped land on the Valley floor, and in the foothills of the Coast Range. Surveys in the northern part of the San Joaquin Valley documented the occurrence of the blunt-nosed leopard lizard in the Firebaugh and Madera Essential Habitat Areas (Williams 1990). Essential Habitat Areas were defined in previous recovery plan editions for this species as undeveloped wildlands containing suitable habitat for the blunt-nosed leopard lizard and essential to the continued survival of the species (USFWS 1980*a*, in litt. 1985).

In the southern San Joaquin Valley, extant populations are known to occur on the Pixley National Wildlife Refuge, Liberty Farms, Allensworth, Kern National Wildlife Refuge, Antelope Plain, Buttonwillow, Elk Hills, and Tupman Essential Habitat Areas, on the Carrizo and Elkhorn Plains, north of Bakersfield around Poso Creek, and in western Kern County in the area around the towns of Maricopa, McKittrick, and Taft (Byrne 1987, R.L. Anderson pers. comm., L.K. Spiegel pers. comm.). Personal observations by D.J. Gemano have been made at the Kern Front oil field, at the base of the Tehachapi Mountains on Tejon Ranch, and just west of the California Aqueduct on the Tejon and San Emizdio Ranches (D.J. Gemano, pers. comm.). Remaining undeveloped lands farther north that support blunt-nosed leopard lizard populations include the Ciervo, Tumey, and Panoche Hills, Anticline Ridge, Pleasant Valley, and the Lone Tree, Sandy Mush Road, Whitesbridge, Horse Pasture, and Kettleman Hills Essential Habitat Areas (CDFG 1985; Figure 47). The species is presumed to be present still in the upper Cuyama Valley, though no recent inventory is known for that area.

3. Life History and Habitat

Food and Foraging.—Blunt-nosed leopard lizards feed primarily on insects (mostly grasshoppers, crickets, and moths) and other lizards, although some plant material is rarely eaten or, perhaps, unintentionally consumed with animal prey. They appear to feed opportunistically on animals, eating whatever is available in the size range they can overcome and swallow. Which lizards are eaten is largely determined by the size and behavior of the prey. Lizard species taken as prey include: side-blotched lizards (*Uta stansburiana*),

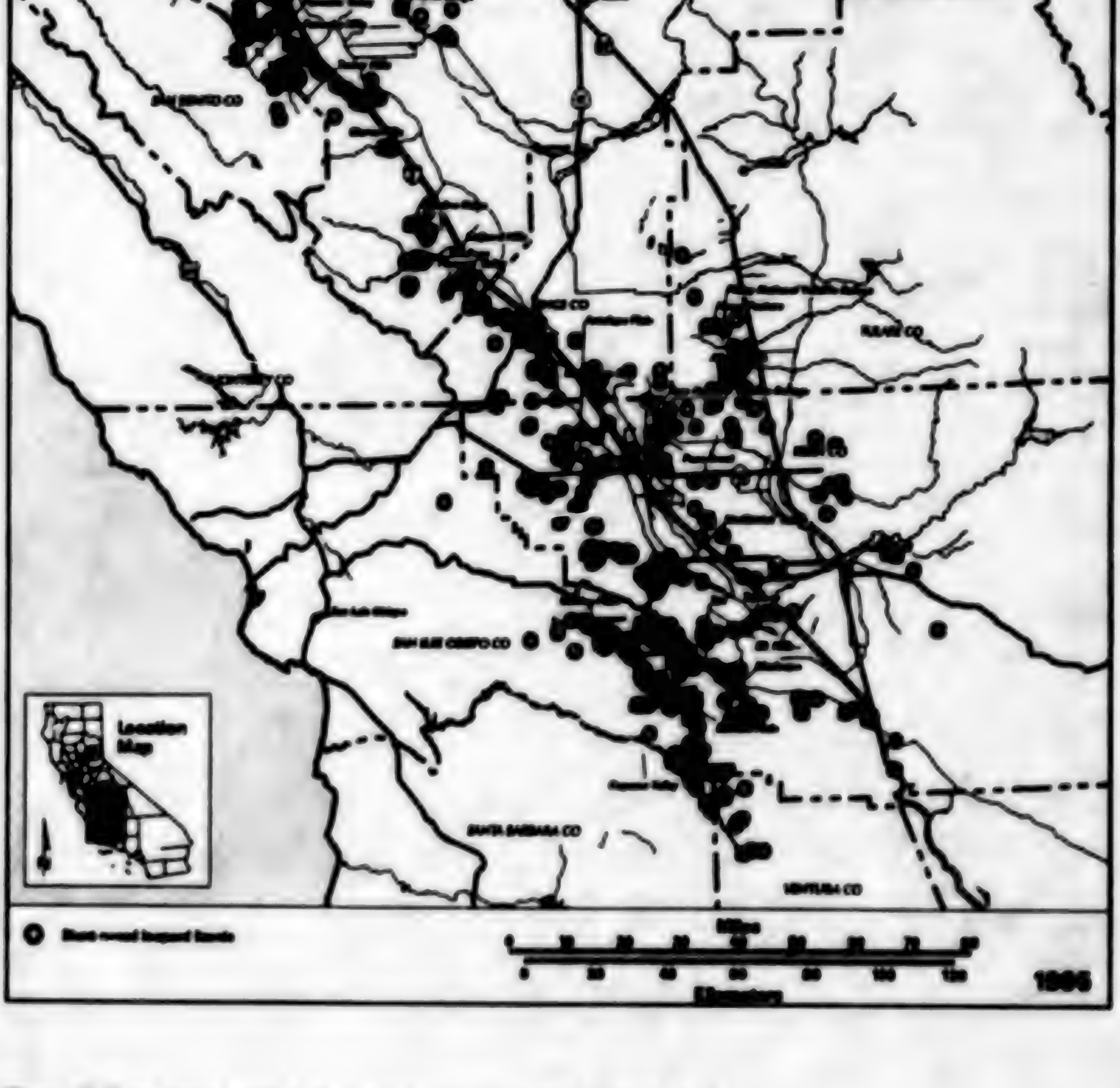

Figure 49. Distributional records for the blunt-nosed leopard lizard (*Gambelia sila*).

coast horned lizards (*Phrynosoma coronatum*), California whiptails (*Cnemidophorus tigris*), and spiny lizards (*Sceloporus* spp.). Young of its own species also are eaten (Montanucci 1965, Kato et al. 1987*a*, Germano and Williams 1994*a*). Because they have similar diets, interspecific competition probably occurs between the blunt-nosed leopard lizard and California whiptail (Montanucci 1965, Tollestrup 1979*b*).

Reproduction and Demography.—Breeding activity begins within a month of emergence from dormancy and lasts from the end of April through the beginning of June, and in some years to near the end of June. During this period, and for a month or more afterward, the adults often are seen in pairs and frequently occupy the same burrow systems (Montanucci 1965, Germano and Williams 1994*b*). Male territories may overlap those of several females, and a given male may mate with several females. Copulation may occur as late as June (Montanucci 1965).

Two to six eggs averaging 15.6 by 25.8 millimeters (0.6 by 1.0 inch) are laid in June and July, and their numbers are correlated with the size of the female (Montanucci 1967). Under adverse conditions, egg-laying may be delayed 1 or 2 months or reproduction may not occur at all (Montanucci 1965, Tollestrup 1979*b*, 1982, Germano et al. 1994). Eggs are laid in a chamber either excavated specifically for a nest or already existing within the burrow system (Montanucci 1965, 1967). Females typically produce only one clutch of eggs per year, but some may produce three or more under favorable environmental conditions (Montanucci 1967, USFWS 1985*a*, Germano and Williams 1992, Williams et al. 1993*b*). After about 2 months of incubation, young hatch from July through early August, rarely to September, and range in size from 42 to 48 millimeters (1.7 to 1.9 inches) snout-vent length (Montanucci 1965, Tollestrup 1982). Before their first winter, young leopard lizards may grow to 88 millimeters (3.5 inches) in snout-vent length (Montanucci 1967).

Sexual maturity is reached in from 9 to 21 months, depending on the sex and environmental conditions (USFWS 1985*a*). Females tend to become sexually mature earlier than males, breeding for the first time after the second dormancy, while males usually do not breed until later (Montanucci 1965, 1967).

The relative proportions of the three age groups (adult, subadult, hatchling or young-of-the-year) change through the activity season as young are added to the population only in August or later and entry into dormancy and differential mortality affects the proportions in age groups above ground. Data based upon surface activity do not give an accurate estimate of the population age structure because the adults cease activity above ground from about 4 weeks before to about the same time as the eggs hatch. The best estimate of the relative proportions of adults and subadults (animals hatched the previous summer) may be made from data gathered in May because both groups are active on the surface then. In May the proportions were 85 percent adults and 15 percent subadults (Montanucci 1965). Montanucci (1965) believed that data gathered in August for subadults and hatchlings yielded the best estimate of their proportions because both groups were active. His data were about 2:1 hatchlings to subadults. Combining these numbers, the population consisted of about 67 percent adults, 11 percent subadults, and 22 percent hatchlings. The age structure of a population on Pixley National Wildlife Refuge consisted of 62 percent adults, 27 percent subadults, and 11 percent hatchlings in 1984 (Uptain et al. 1985).

Age structure of adults during a 7-year period on the Elkhorn Plain (Williams et al. 1993*a*, Endangered Species Recovery Program unpubl. data), was determined in 1995; percentages of 2, 3, 4, and 5 year-old males were 69.5, 21, 6.5, and 2, respectively. Percentages of females 2, 3, and 4 years old were 70, 22, and 7.5; none were recaptured older than 4 years. Parker and Pianka (1976) made estimates for the long-nosed leopard lizard based on their data for a Utah population, which are consistent with the age structure and reproductive situation described for the blunt-nosed leopard lizard. Maximum longevity would thus be 8 to 9 years with an annual survivorship of about 50 percent.

In several populations, and during most of the year, males appear to outnumber females by a ratio of 2:1 (Montanucci 1965, Uptain et al. 1985, Kato et al. 1987*b*). Mullen (1981) reported that the ratio of males to females was 3:1, whereas Montanucci (1965) found that the numbers in a Valley floor population were equal. Uptain et al. (1985) showed that, although 63 percent of the hatchlings in a population on Pixley National Wildlife Refuge were male, the male:female ratio varied seasonally from 2:1 in the spring, to 1:1 in the summer, and to 2:3 in the fall. These were all based on short-term studies. In contrast, populations on two plots on the Elkhorn Plain over several years typically had adult and subadult sex ratios of about 1:1 (1:1.04). Females outnumbered males more often than the reverse during census periods in May and June. Hatchling sex ratios, however, showed the opposite, with males outnumbering females, most censuses with ratios varying between about 1.5:1 and 2.5:1 male:female (Williams et al. 1993*b*, Germano and Williams 1994*b*, Endangered Species Recovery Program unpubl. data).

Male and female home ranges often overlap. The mean home range size varies from 0.1 to 1.1 hectares (0.25 to 2.7 acres) for females and 0.2 to 1.7 hectares (0.52 to 4.2 acres) for males (Tollestrup 1983, Kato et al. 1987*b*).

There are no current overall population size estimates for the species. Uptain et al. (1985) reported densities ranging from 0.3 to 10.8 lizards per hectare (0.1 to 4.2 per acre) for a population on the Pixley National Wildlife Refuge in Tulare County. In a previous study of this population, Tollestrup (1979) estimated an average density of 3.3 lizards per hectare (1.3 per acre). In 1991, after three previous years of severe drought, two 8.1-hectare (20-acre) plots had estimated densities of 6.7 and 7.0 lizards per hectare (2.7 and 2.8 per acre) on Pixley National Wildlife Refuge (Williams and Germano 1991). On the Elkhorn Plain, estimated population size on two 8.1-hectare plots of adult and subadult blunt-nosed leopard lizards in June (period of peak above-ground activity) varied between 0 in 1990 to more than 170 in 1993. Only subadult lizards were active above ground in April and no lizards were active by June 1990, the year of severest drought (Williams et al. 1993*b*, Germano et al. 1994, D. J. Germano and D.F. Williams unpubl. data). Turner et al. (1969) estimated that the average density of a southern Nevada population of the long-nosed leopard lizard was 3 lizards per hectare (1.2 per acre). Population densities in marginal habitat generally do not exceed 0.5 blunt-nosed leopard lizards per hectare (0.2 per acre) (Mullen 1981, Le Fevre in litt. 1976, Madrone Associates 1979).

Behavior and Species Interactions.—Social behavior is more highly developed in the blunt-nosed leopard lizard than in the long-nosed leopard lizard. For example, territorial defense and related behavioral activity are completely absent in the long-nosed leopard lizard, whereas blunt-nosed leopard lizards are highly combative in establishing and maintaining territories (Montanucci 1970). In addition, Tollestrup (1979, 1983) observed six distinct behavioral displays specific to the blunt-nosed leopard lizard. Behavioral displays of all types were more frequent during the breeding season.

Leopard lizards use small rodent burrows for shelter from predators and temperature extremes (Tollestrup 1979*b*). Burrows are usually abandoned ground squirrel tunnels, or occupied or abandoned kangaroo rat tunnels (Montanucci 1965). Each lizard uses several burrows without preference, but will avoid those occupied by predators or other leopard lizards. Montanucci (1965) found that in areas of low mammal burrow density, lizards will construct shallow, simple tunnels in earth berms or under rocks. While foraging, immature lizards also take cover under shrubs and rocks.

Potential predators of blunt-nosed leopard lizards include whipsnakes, gopher snakes, glossy snakes (*Arizona elegans*), western long-nosed snakes (*Rhinocheilus lecontei*), common king snakes, western rattlesnakes, loggerhead shrikes (*Lanius ludovicianus*), American kestrels (*Falco sparverius*), burrowing owls, greater roadrunners (*Geococcyx californianus*), golden eagles (*Aquila chrysaetos*), hawks, California ground squirrels, spotted skunks (*Spilogale putorius*), striped skunks (*Mephitis mephitis*), American badgers, coyotes, and San Joaquin kit foxes (Montanucci 1965, Tollestrup 1979*b*). Blunt-nosed leopard lizards are hosts to endoparasites such as nematodes, and ectoparasites such as mites and harvest mites (Montanucci 1965).

Activity Cycles.—Seasonal above-ground activity is correlated with weather conditions, primarily temperature. Optimal activity occurs when air temperatures are between 23.5 degrees and 40.0 degrees Celsius (74 and 104 degrees Fahrenheit) and ground temperatures are between 22 degrees and 36 degrees Celsius (72 and 97 degrees Fahrenheit) (USFWS 1985*a*, J. Brode pers. comm.). Some activity has been observed at temperatures as high as 50 degrees Celsius (122 degrees Fahrenheit) (O'Farrell and Kato 1980, Mullen 1981, Tollestrup 1976, Williams and Tordoff 1988). Body temperatures range from 32.2 to 42.0 degrees Celsius (90 and 108 degrees Fahrenheit) (Cowles and Bogert 1944, Mullen 1981). Because diurnal activity is temperature dependent, blunt-nosed leopard lizards are most likely to be observed in the morning and late afternoon during the hotter days (Tollestrup 1976). Smaller lizards and young have a wider activity range than the adults (Montanucci 1965). This results in the smaller, subadult lizards emerging from hibernation earlier than adults, remaining active later in the year, and being active during the day earlier and later than adults (Montanucci 1965). Adults are active above ground in the spring months from about March or April through June or July, with the amount of activity decreasing so that by the end of June or July almost all sightings are of subadult and hatchling leopard lizards (Williams et al. 1993*b*). Also, following the breeding season, the proportion of each sex active changes as males tend to cease surface activity sooner than females (Montanucci 1967, Williams and Tordoff 1988). Adults captured on the surface in August are about 70 percent females (Montanucci 1967). Adults retreat to their burrows to *brummate* (dormancy in *poikilothermic* vertebrates [having a body temperature that varies with the temperature of its surroundings]), beginning in August or September, but hatchlings are active until mid-October or November, depending on weather.

Habitat and Community Associations.—Blunt-nosed leopard lizards inhabit open, sparsely vegetated areas of low relief on the San Joaquin Valley floor and in the surrounding foothills (Smith 1946, Montanucci 1965). On the Valley floor, they are most commonly found in the Nonnative Grassland and Valley Sink Scrub communities described by Holland (1986). The Valley Sink Scrub is dominated by low, alkali-tolerant shrubs of the family Chenopodiaceae, such as iodine bush, and seepweeds. The soils are saline and alkaline lake bed or playa clays that often form a white salty crust and are occasionally covered by introduced annual grasses. Prior to agricultural development, Valley Sink Scrub was widespread around Kern, Buena Vista, Tulare, and Goose lakes and extended north to the Sacramento Valley along the trough of the San Joaquin Valley. Today, nearly all the remaining Valley sink scrub on the Valley floor is seasonally flooded fragments of this historical community. This community corresponds to two that Tollestrup (1976) described as *Allenrolfea* grassland and *Suaeda* flat.

Valley Needlegrass Grassland, Nonnative (Annual) Grassland, and Alkali Playa (Holland 1986) also provide suitable habitat for the lizard on the Valley floor. Valley Needlegrass Grassland is dominated by native perennial bunchgrasses, including purple needlegrass (*Nassella pulchra*) and alkali sacaton. Associated with the perennial grasses are native and introduced annual plants. Both the Valley Needlegrass Grassland and Nonnative/Annual Grassland occur on fine-textured soils and probably were widespread in the Valley before large areas were converted to agriculture. The Alkali Playa community occurs on poorly drained, saline and alkaline soils in small, closed basins. The small, widely spaced, dominant shrubs include: iodine bush, saltbushes, and greasewood (*Sarcobatus vermiculatus*).

Blunt-nosed leopard lizards also inhabit Valley Saltbush Scrub, which is a low shrubland, with an annual grassland understory, that occurs on the gently sloping alluvial fans of the foothills of the southern San Joaquin Valley and adjacent Carrizo Plain. This community is dominated by the chenopod shrubs, common saltbush (*Atriplex polycarpa*) and spiny saltbush (*Atriplex spinifera*), and is associated with non-alkaline, sandy or loamy soils. Tollestrup (1976) described this plant community as *Atriplex* grassland. Similar to this community, but dominated principally by common saltbushes, are the Sierra-Tehachapi Saltbush Scrub (extending [illegible] the southern Sierra Nevada north of Porterville to the Grapevine in the Tehachapi Mountains) and Interior Coast Range Saltbush Scrub. The latter ranges from Pacheco Pass to Maricopa but, for the most part, has been converted by grazing and fire to Nonnative/Annual Grassland. Other foothill communities that occur within the range of the blunt-nosed leopard lizard are Upper Sonoran Subshrub Scrub and Serpentine Bunchgrass (Holland 1986). In general, leopard lizards are absent from areas of steep slope, dense vegetation, or areas subject to seasonal flooding (Montanucci 1965).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—Since the 1870s and the advent of irrigated agriculture in the San Joaquin Valley, more than 95 percent of the original natural communities have been destroyed. This dramatic loss of natural communities was the result of cultivation, modification and alteration of existing communities for petroleum and mineral extraction, pesticide applications, off-road vehicle use, and construction of transportation, communications, and irrigation infrastructures. These processes collectively have caused the reduction and fragmentation of populations and decline of blunt-nosed leopard lizards (Stebbins 1954, Montanucci 1965, USFWS 1980*a*, 1985*a*, Germano and Williams 1993).

Farming began in the Valley as a direct response to increased demands for local food supplies, created by the migration of settlers to California during the 1849 Gold Rush (California Department of Water Resources 1974). Land conversion was accelerated in the 1920s with the advent of reliable electrical groundwater pumps and in the 1950s and 1960s with importation of water via Federal and State water projects (San Joaquin Valley Interagency Drainage Program 1979). By 1985, 94 percent of wildlands on the Valley floor had been lost to agricultural, urban, petroleum, mineral, or other development (USFWS 1985*c*, CDFG 1985).

Stebbins (1954) first recognized that agricultural conversion of its habitat was causing the elimination of the blunt-nosed leopard lizard. The cumulative effects of the dramatic decline in its available habitat and degradation of existing habitat by a variety of human activities have resulted in the lizard's present status as endangered.

In the first blunt-nosed leopard lizard recovery plan (USFWS 1980*a*), 20 Habitat Units were identified as "Essential" to the continued survival of the blunt-nosed leopard lizard, though these did not have any legal protection equivalent to critical habitat. Ten of these habitat units were recommended as having priority for protection (USFWS 1980*a*, in litt. 1985). Between 1977 and 1985, over 30,000 hectares (74,000 acres) of this important Valley-floor habitat were destroyed.

Threats to Survival.—Habitat disturbance, destruction, and fragmentation continue as the greatest threats to blunt-nosed leopard lizard populations. Construction of facilities related to oil and natural gas production, such as well pads, wells, storage tanks, sumps, pipelines, and their associated service roads degrade habitat and cause direct mortality to leopard lizards, as do leakage of oil from pumps and transport pipes, and storage facilities, surface mining, and off-highway vehicle traffic (Mullen 1981, USFWS 1985*a*, Kato and O'Farrell 1986, Madrone Associates 1979, Chesemore 1980). Dumping of waste oil and highly saline wastewater into natural drainage systems also degrades habitat and causes direct mortality, but these activities are no longer permitted. Lizards displaced by degraded or lost habitat may be unable to survive in adjacent habitat if it is already occupied or unsuitable for colonization (USFWS 1985*a*, Williams and Tordoff 1988). Direct mortality occurs when animals are killed or buried in their burrows during construction, killed by vehicle traffic on access roads, drowned or mired in pools of oil (Montanucci 1965, Mullen 1981, Kato and O'Farrell 1986, Kato et al. 1987*b*) and uncovered oil cellars (USFWS 1988), or fall into excavated areas from which they are unable to escape (O'Farrell and Sauls 1987).

Although lizards occur in areas of light petroleum development and recolonize oil fields that have been abandoned (O'Farrell and Kato 1980, Chesemore 1980, O'Farrell 1980, Williams in litt. 1989), their population densities decrease as oil activity increases (Jones 1980, O'Farrell and Kato 1980, Mullen 1981, Kato and O'Farrell 1986, O'Farrell and Sauls 1987). Eighty-three percent of the blunt-nosed leopard lizard population on Elk Hills Naval Petroleum Reserves in California inhabited areas where little or no petroleum-related activity had occurred (Kato and O'Farrell 1986). D.J. Germano (pers. comm.) reports relatively high numbers of blunt-nosed leopard lizards at the Kern Front Oil Fields despite the high level of oil activity.

Livestock grazing can result in removal of herbaceous vegetation and shrub cover, destruction of rodent burrows used by lizards for shelter, and associated soil erosion if the stocking rate is too high or animals are left on the range too long after annual plants have died (Chesemore 1981, Williams and Tordoff 1988). Unlike cultivation of row crops, which precludes use by leopard lizards, light or moderate grazing may be beneficial (USFWS 1985*a*, Germano and Williams 1993, Chesemore 1980). Chesemore (1980) suggested that 15 percent to 30 percent ground cover was optimal for leopard lizard habitat and greater than 50 percent was unsuitable. Researchers have hypothesized that leopard lizards prefer lightly grazed grasslands since these are dominated by Arabian grass, a low, sparsely growing, introduced annual grass, whereas ungrazed areas are dominated by red brome which is a taller, denser introduced grass (Mullen 1981, Chesemore 1980). However, domination by Arabian grass may be partly or predominately due to precipitation, soil structure, and other environmental variables instead of grazing intensity, based on long-term studies at several sites within the geographic range of the blunt-nosed leopard lizard (Williams et. al 1993*b*, Germano and Williams 1994*b*, Williams and Nelson in press, Williams and Germano 1991). On the Elkhorn Plain Ecological Reserve, high percentages of ground cover (nearly 100 percent in 1991–1993, 1995) may not have provided optimum habitat conditions, but grasshoppers and large moths and other prey for leopard lizards were abundant under these conditions. Blunt-nosed leopard lizards survived such conditions in similar proportions in grazed and nongrazed areas both in years of low and high plant productivity, though drought and lack of grazing during several years of the study makes results inconclusive (Williams et al. 1993*b*, Germano et al. 1994, Germano and Williams 1994*b*, Williams and Nelson in press, D.F. Williams unpubl. data).

The use of pesticides may directly and indirectly affect blunt-nosed leopard lizards (Germano and Williams 1993, Jones and Stokes 1977, California Department of Food and Agriculture 1984, Williams and Tordoff 1988). The insecticide malathion has been used since 1969 to control the beet leafhopper (California Department of Food and Agriculture 1984). California Department of Food and Agriculture treats areas on the west side of the San Joaquin Valley, from Merced to San Luis Obispo Counties, up to three times a year, depending on the seasonal densities of the sugar beet leafhopper and whether or not it is carrying the curly-top virus (H.L. Foote pers. comm.). Pretreatment surveys for blunt-nosed leopard lizards are conducted so that inhabited areas can be avoided, if possible.

Although the acute and chronic effects of malathion toxicity to leopard lizards are unknown (R.A. Marovich pers. comm.), Hall and Clark (1982) found that acute oral administration of malathion was relatively non-toxic to another lizard of the family Iguanidae. The most important effects of malathion on the blunt-nosed leopard lizard may be those associated with the reduction of insect prey populations (California Department of Food and Agriculture 1984). Because it degrades in approximately 48 hours, the direct effect of this insecticide on the abundance of prey species is thought to last for 2 to 5 days (California Department of Food and Agriculture 1984). Aerial application of malathion may reduce the availability of food for reproducing lizards in the spring, and later for hatchlings when they should be storing fat to sustain themselves during their first winter (Kato and O'Farrell 1986). During recent consultation with the Service, the California Department of Food and Agriculture's curly top virus control program was modified to increase protection measures, including increasing the use of biocontrol and integrated pest management techniques in blunt-nosed leopard lizard habitat (USFWS in litt. 1997*a*).

Blunt-nosed leopard lizard mortality is known to occur as a result of regular automobile traffic and off-road vehicle use (Tollestrup 1979*b*, Uptain et al. 1985, Williams and Tordoff 1988). Little information is available regarding the relative effect of this cause of mortality, but habitat fragmentation has accompanied the construction of roads. Typically roads surround and often bisect remaining fragments of habitat, increasing the risks of mortality by vehicles and strengthening the population effects of isolation.

5. Conservation Efforts

The blunt-nosed leopard lizard was listed as endangered by the U.S. Department of the Interior in 1967 (USFWS 1967) and by the State of California in 1971 (Table 1). A recovery plan was first prepared in 1980 (USFWS 1980*a*) and revised in 1985 (USFWS 1985*a*). Conservation efforts have included habitat and population surveys, studies of population demography and habitat management, land acquisition, and development of management plans for public lands that have benefitted blunt-nosed leopard lizards as well as other listed species (see the Introduction, 3. Conservation Efforts at the Community Level and Table 2).

Large-scale habitat surveys include those for the California Energy Commission's Southern San Joaquin Valley Habitat Preservation Program (Anderson et al. 1991), the Carrizo Plain Natural Area (Kakiba-Russell et al. 1991), Elk Hills Naval Petroleum Reserves in California (O'Farrell and Matthews 1987, O'Farrell and Sauls 1987, EG&G Energy Measurements 1995*a,b*), USBLM lands in Fresno, San Benito, and Monterey Counties (O'Farrell et al. 1981), and a survey of 12,000 hectares (30,000 acres) of natural land in western Madera County (Williams 1990). There also have been numerous smaller-scale preproject surveys as part of the Sec. 7 and 10(a) permit processes of the Endangered Species Act, and National Environmental Policy Act and California Environmental Quality Act laws and regulations. Most of these have taken place in the southern San Joaquin Valley in Kern and western Kings Counties.

The CDFG conducted aerial surveys between 1976 and 1985 to determine the extent of remaining natural lands in the San Joaquin Valley (USFWS 1980*a*, 1985*a*). Survey maps were compared with baseline maps hand drawn from EROS 45.7 by 45.7-centimeter color infrared high altitude photos, taken in August 1974. The loss of undeveloped land in each of 20 Essential Habitat areas was compared for the years 1983 and 1985, the years most recent surveys were conducted.

In 1985, USFWS (USFWS in litt. 1985) proposed that 3,345 hectares (8,265 acres) in the Firebaugh, Whitesbridge, and Pixley Refuge Essential Habitat areas be acquired using Land and Water Conservation Fund

Act funds. However, because of funding constraints, this plan has not been implemented.

Studies of population ecology and habitat management of leopard lizards have been conducted by several researchers funded by the USBLM, U.S. Department of Energy, Bureau of Reclamation, Service, and CDFG. The results of two research investigations of blunt-nosed leopard lizard food habits and home range size have been published since 1985 (Kato et al. 1987*b*, 1987*b*). Studies of demography and habitat management on the Elkhorn Plain have been on-going since 1987 (Williams et al. 1993*b*, Germano and Williams 1994*b*, Germano et al. 1994, Endangered Species Recovery Program unpubl. data). Similarly, since 1985, studies of demography have been ongoing at Pixley National Wildlife Refuge (Uptain et al. 1992, Williams and Germano 1991, Endangered Species Recovery Program unpubl. data). Other studies of habitat management and restoration have taken place at the Kern Fan Element by the California Department of Water Resources (J. Shelton and S. Juarez pers. comm.).

Though population viability analyses are an important aspect of conservation planning for this species, recent single-population analyses (Buechner 1989, Endangered Species Recovery Program studies in progress) are inadequate for two main reasons: (1) there are insufficient data on demographics of blunt-nosed leopard lizards from several sites representing the range of environmental conditions to which the species is exposed; and (2) the data are not representative of the temporal variation of the environment. Before modeling can become a useful tool for conservation planning, data needed to conduct metapopulation modeling must be gathered. These data include demographics of individual populations, the carrying capacity of the habitat of each, and their connectivity (rate of movement). Despite the shortcomings of current information, recent studies have shown that blunt-nosed leopard lizards can withstand severe, long term drought by remaining dormant for up to 22 months, and have the reproductive capacity for irruptive population growth when conditions are favorable (Williams et al. 1993*b*, Germano et al. 1994, Germano and Williams 1994*b*).

U.S. Environmental Protection Agency County bulletins governing use of rodenticides have greatly reduced the risk of significant mortality to blunt-nosed leopard lizard populations by State and county rodent-control activities. The California Environmental Protection Agency, California Department of Food and Agriculture, county agricultural departments, CDFG, and the U.S. Environmental Protection Agency collaborated with the Service in the development of County Bulletins that both are efficacious and acceptable to land owners (R.A. Marovich pers. comm.).

6. Recovery Strategy

The more important questions that must be addressed before or simultaneous with purchase of land or conservation easements, is how to preserve and enhance populations on existing habitat. Substantial habitat is in public ownership or a conservation program, but appropriate habitat management prescriptions for these parcels mostly are unknown. No parcel currently is being specifically managed to optimize habitat conditions for this species. Thus, the three most important factors in recovering the blunt-nosed leopard lizard are:

1. determining appropriate habitat management and compatible land uses for blunt-nosed leopard lizards;

2. protecting additional habitat for them in key portions of their range; and

3. gathering additional data on population responses to environmental variation at representative sites in their extant geographic range.

A population monitoring program and a range-wide population survey are needed to determine current population sizes and habitat conditions, track lizards' responses to environmental variation and changing land uses, and rank areas and parcels for protection by purchase of title or easement. Special attention must be directed to surveys in potential habitat in central Merced County, where ground surveys have not been conducted.

Also needed is an analysis of extinction patterns on different-sized, isolated blocks of natural land on the Valley floor to gain insight into the effects of habitat size and diversity on population viability. Because several important populations are isolated on fragmented natural land on the Valley floor and along its southern and western perimeter, ultimately, determining viable population size, genetic variation, and methods to enhance population movements and restore habitat on retired farmlands are needed to ensure recovery.

Recovery Actions.—Principal recovery actions for the blunt-nosed leopard lizard should focus on information needed to make informed decisions about land acquisition and habitat management and restoration, and measure progress toward recovery. Habitat protection is important, and in some portions of the geographic range of blunt-nosed leopard lizards, it has a high priority. Yet, while habitat protection goals may require many years to achieve, and some may never be reached, other actions must be implemented. Needed actions are:

1. Determine appropriate habitat management and compatible land uses for blunt-nosed leopard lizards.

2. Conduct range-wide surveys of known and potential habitat for presence and abundance of blunt-nosed leopard lizards.

3. Protect additional habitat for them in key portions of their range; areas of highest priority to target for protection are:

    a. Natural lands in western Madera County;

    b. Natural lands in the Panoche Valley area of Silver Creek Ranch, San Benito County;

    c. Agricultural and natural land between the north end of the Kettleman Hills and the Guijarral Hills and the Guijarral Hills and Anticline Ridge (western rim of Pleasant Valley, Fresno County) to restore and protect a corridor of continuous habitat for blunt-nosed leopard lizards and other species without the ability to move through irrigated farmland;

    d. Natural lands west of Highway 33 and east of the coastal ranges between the Pleasant Valley, Fresno County, on the north and McKittrick Valley, Kern County, on the south;

    e. Natural lands of the linear, piedmont remnants of their habitat west of Interstate Highway 5 between Pleasant Valley and Panoche Creek, Fresno County;

    f. Natural lands in upper Cuyama Valley.

4. Gather additional data on population responses to environmental variation at representative sites in its extant geographic range.

5. Design and implement a range-wide population monitoring program.

6. Protect additional habitat for blunt-nosed leopard lizards in the following areas (all are of equal priority):

    a. Natural and retired agricultural lands around Pixley National Wildlife Refuge, Tulare County, with an objective of expanding and connecting the Refuge units with each other and with the Allensworth Ecological Reserve;

    b. Natural land in and around the Elk Hills Naval Petroleum Reserves in California and Lokern Natural Area with the objective of expanding and connecting existing lands with conservation programs;

    c. Natural and retired agricultural lands in the Semitropic Ridge Natural Area, Kern County, with the objective of expanding and connecting existing reserves and refuges.

L. San Joaquin Kit Fox
(*Vulpes macrotis mutica*)

1. Description and Taxonomy

Taxonomy.—The kit fox, *Vulpes macrotis*, was described by C. Hart Merriam (1888). The area of the type locality, near Riverside in Southern California, is now highly urbanized. Eight subspecies were recognized historically (e.g., Hall 1981). *V. m. mutica*, the San Joaquin kit fox, was first described by Merriam (1902). Today, only *V. m. macrotis* and *V. m. mutica* are recognized (Mercure et al. 1993). The type locality is near Tracy, San Joaquin County, California.

Several different taxonomies for the species and subspecies of small, North American foxes have been proposed over the last 110 years (historical literature summarized by Hall 1946, Hall and Kelson 1959, Rohwer and Kilgore 1973, Waithman and Roest 1977, Hall 1981). Two recent studies examined the evolutionary and taxonomic relationships among small, North American foxes (Dragoo et al. 1990, Mercure et al. 1993). Dragoo et al. (1990) concluded that all North American arid-land foxes belonged to the species *V. velox* (swift fox). The subspecific statuses of the taxa historically regarded as subspecies of *V. macrotis* also were challenged by Dragoo et al. (1990), who recommended that all be synonymized under *V. velox macrotis*. Genetic work by Mercure et al. (1993) led them to conclude that, though there was evidence of hybridization between kit and swift foxes over a limited geographic area, they should be considered separate species. Further, Mercure et al. concluded that of the traditional subspecies of the kit fox, the San Joaquin Valley population is the most distinct and should be considered a subspecies (1993, p. 1323). Their data recognize the swift fox as a separate monotypic species, and two subspecies of kit foxes: *V. macrotis macrotis*, found throughout the remaining habitat within the historical range of the species, except the San Joaquin kit fox range; and *V. macrotis mutica*, the San Joaquin kit fox.

Description.—The kit fox is the smallest canid species in North America and the San Joaquin kit fox is the largest subspecies in skeletal measurements, body size, and weight. Grinnell et al. (1937) found a difference in body size between males and females: males averaged 80.5 centimeters (31.7 inches) in total length, and 29.5 centimeters (11.6 inches) in tail length; females averaged 76.9 centimeters (30.3 inches) in total length, and 28.4 centimeters (11.2 inches) in tail length. Kit foxes have long slender legs and are about 30 centimeters (12 inches) high at the shoulder. The average weight of adult males is 2.3 kilograms (5 pounds), and of adult females is 2.1 kilograms (4.6 pounds) (Morrell 1972).

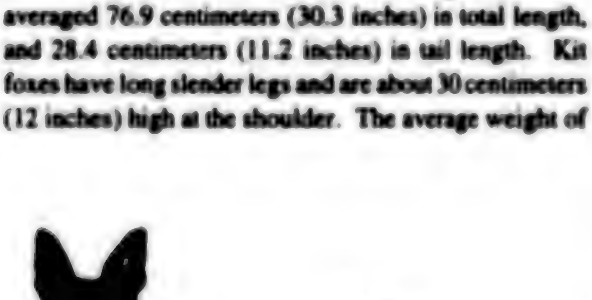

Figure 50. Illustration of a kit fox by Jodi Sears (© D.F. Williams)

General physical characteristics of kit foxes include a small, slim body, relatively large ears set close together, narrow nose, and a long, bushy tail tapering slightly toward the tip (Figure 50). The tail is typically carried low and straight.

Color and texture of the fur coat of kit foxes varies geographically and seasonally. The most commonly described colorations are buff, tan, grizzled, or yellowish-gray dorsal coats (McGrew 1979). The guard hairs on the back are black tipped, which accounts for the grizzled appearance (Bell 1994). Two distinctive coats develop each year: a tan summer coat and a silver-gray winter coat (Morrell 1972). The undersides vary from light buff to white (Grinnell et al. 1937), with the shoulders, lower sides, flanks and chest varying from buff to a rust color. The ear pinna (external ear flap) is dark on the back side, with a thick border of white hairs on the forward-inner edge and inner base. The tail is distinctly black-tipped.

Identification.—The foot pads of kit foxes are small by comparison with other canids. A sample of 21 tracks from throughout the San Joaquin Valley had an average length of 3.1 centimeters (1.2 inches) and an average width of 2.6 centimeters (1 inch) (Orloff et al. 1993). Other characteristics such as the degree to which the feet are furred and the size, shape, and configuration of the pads distinguish kit fox tracks from those of co-occurring canids and domestic cats (Orloff et al. 1993).

Because all three fox species that occur in the San Joaquin Valley are primarily nocturnal, identification of free-living, and often fast-moving, animals can be a challenge. The black-tipped tail and coat color differences usually distinguish kit foxes from red foxes (*V. vulpes*). At 4 to 5 kilograms (8 to 11 pounds), the red fox also is much heavier than the kit fox. Gray foxes (*Urocyon cinereoargenteus*) however are sometimes misidentified as kit foxes, especially in winter when the kit fox coat is thicker and has more gray. Both species have a black tail tip but gray foxes also have a distinctive black stripe running along the top of the tail. Gray foxes are more robust than kit foxes; they are heavier with an average body weight of about 3.6 kilograms (8 pounds) (Grinnell et al. 1937). However, San Joaquin kit foxes have longer ears, averaging 8.6 centimeters (3.4 inches) compared with 7.8 centimeters (3 inches) for gray foxes (Grinnell et al. 1937).

2. Historical and Current Distribution

Historical Distribution.—The historical range was first defined by Grinnell et al. (1937). Prior to 1930, kit foxes inhabited most of the San Joaquin Valley from southern Kern County north to Tracy, San Joaquin County, on the west side, and near La Grange, Stanislaus County, on the east side. These authors believed that by 1930 the kit fox range had been reduced by more than half, with the largest portion of the range remaining in the southern and western parts of the Valley (Figure 51), though they provided no indication for why they believed foxes had been eliminated from most of the east side and Valley floor.

Current Distribution.—Although the San Joaquin kit fox has been listed as endangered for over 30 years, there has never been a comprehensive survey of its entire historical range. And, despite the loss of habitat and apparent decline in numbers since the early 1970s, there has been no new survey of habitat that was then thought to be occupied (Morrell 1975).

Despite the lack of a comprehensive survey, local surveys, research projects and incidental sightings indicate that kit foxes currently inhabit some areas of suitable habitat on the San Joaquin Valley floor and in the surrounding foothills of the coastal ranges, Sierra Nevada, and Tehachapi Mountains, from southern Kern County north to Contra Costa, Alameda, and San Joaquin Counties on the west, and near La Grange, Stanislaus County on the east side of the Valley (Williams in litt. 1990), and some of the larger scattered islands of natural land on the Valley floor in Kern, Tulare, Kings, Fresno, Madera, and Merced Counties (Figure 51). Kit foxes also occur westward into the interior coastal ranges in Monterey, San Benito, and Santa Clara Counties (Pajaro River watershed), in the Salinas River watershed, Monterey and San Luis Obispo Counties, and in the upper Cuyama River watershed in northern Ventura and Santa Barbara Counties and southeastern San Luis Obispo County. Kit foxes are also known to live within the city limits of the city of Bakersfield in Kern County (Laughrin 1970, Jensen 1972, Morrell 1975, USFWS 1983, Swick 1973, Waithman 1974*a*, Endangered Species Recovery Program unpubl. data).

Some researchers have suggested that as San Joaquin Valley natural lands were cultivated or otherwise developed, displaced kit foxes colonized nearby valleys and foothills (Laughrin 1970, Jensen 1972); however, there is no concrete evidence to support this assertion. As early as 1925, Grinnell et al. reported kit fox specimens from the Panoche Creek area in the foothills of western Fresno County, and east of Rose Station (Fort Tejon) in southern Kern County at an elevation of 363 meters (1,200 feet) (Grinnell et al. 1937, USFWS 1983). Therefore, it is more probable that kit foxes have always occurred in these areas, possibly at low density.

The largest extant populations of kit foxes are in western Kern County on and around the Elk Hills and Buena Vista Valley, Kern County, and in the Carrizo Plain Natural Area, San Luis Obispo County. The kit fox populations of Elk Hills and the City of Bakersfield, Kern County (B.L. Cypher pers. comm.), Carrizo Plain Natural Area, San Luis Obispo County (White and Ralls 1993, Ralls and White 1995), Ciervo-Panoche Natural Area, Fresno and San Benito Counties (Endangered Species Recovery Program), Fort Hunter Liggett, Monterey County (V. Getz pers. comm.), and Camp Roberts, Monterey and San Luis Obispo Counties (W. Berry pers. comm.) have been recently, or are currently, the focus of various research projects. Though monitoring has not been continuous in the central and northern portions of the range, populations were recorded in the late 1980s at San Luis Reservoir, Merced County (Briden et al. 1987), North Grasslands and Kesterson National Wildlife Refuge area on the Valley floor, Merced County (Paveglio and Clifton 1988), and in the Los Vaqueros watershed, Contra Costa County in the early 1990s (V. Getz pers. comm.). Smaller populations and isolated sightings of kit foxes are also known from other parts of the San Joaquin Valley floor, including Madera County and eastern Stanislaus County (Williams 1990).

3. Life History and Habitat

Food and Foraging.—Diet of kit foxes varies geographically, seasonally, and annually, based on variation in abundance of potential prey. In the southern portion of their range, kangaroo rats, pocket mice, white-footed mice (*Peromyscus* spp.), and other nocturnal rodents comprise about one-third or more of their diets. Kit foxes there also prey on California ground squirrels, black-tailed hares, San Joaquin antelope squirrels, desert cottontails, ground-nesting birds, and insects (Scrivner et al. 1987*a*). Vegetation and insects occur frequently in feces. Grass is the most commonly ingested plant material (Morrell 1971, C.A. Vanderbilt-White pers. comm.). In the central portion of their geographic range,

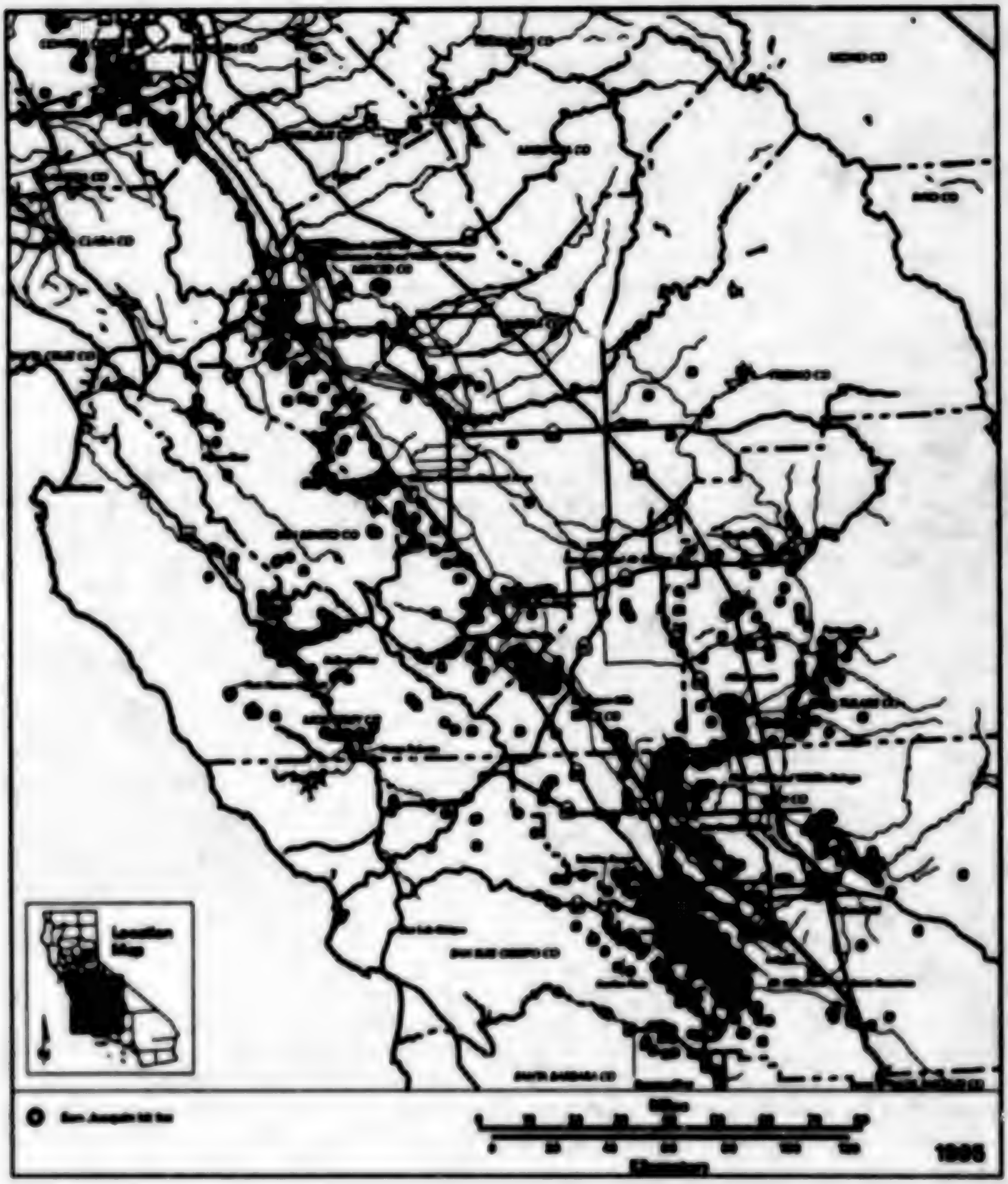

Figure 51. Map of distributional records for the San Joaquin kit fox (*Vulpes macrotis mutica*).

defined here as Kings, Tulare, Fresno, Madera, San Benito, Merced, Stanislaus, and Monterey Counties, known prey species include white-footed mice, insects, California ground squirrels, kangaroo rats, San Joaquin antelope squirrels, black-tailed hares, and chukar (*Alectoris chukar*) (Jensen 1972, Archon 1992), listed in approximate proportion of occurrence in fecal samples. In the northern part of their range, defined here as San Joaquin, Alameda and Contra Costa Counties, kit foxes most frequently consume California ground squirrels (Orloff et al. 1986). Cottontails, black-tailed hares, pocket mice, and kangaroo rats also are eaten (Hall 1983, D.F. Williams unpubl. data). Though ground squirrels are diurnal and kit foxes are predominantly nocturnal, kit foxes are commonly seen during the day during late spring and early summer (Orloff et al. 1986).

Reproduction and Demography.—Kit foxes can breed when 1 year old, but may not breed their first year of adulthood (Morrell 1972). Adult pairs remain together all year, sharing the home range but not necessarily the same den (K. Ralls pers. comm.). During September and October, adult females begin to clean and enlarge natal or pupping dens (they select dens with multiple openings; Morrell 1972). Mating and conception take place between late December and March (Egoscue 1956, Morrell 1972, Zoellick et al. 1987*a*, Spiegel et al. in press). The median gestation period is estimated to range from 48 to 52 days (Spiegel et al. in press). Litters of from two to six pups are born sometime between February and late March (Egoscue 1962, Morrell 1972, Zoellick et al. 1987*a*, Spiegel et al. in press).

The female is rarely seen hunting during the time she is lactating. During this period the male provides most of the food for her and the pups. The pups emerge above ground at slightly more than 1 month of age. After 4 to 5 months, usually in August or September, the family bonds begin to dissolve and the young begin dispersing. Occasionally a juvenile female will remain with the adult female for several more months (O'Neal et al. 1992, Spiegel et al. in press). Offspring of both sexes sometimes remain with their parents through the following year and help raise a subsequent litter (White and Ralls 1993, Spiegel et al. in press, B.L. Cypher pers. comm.).

Reproductive success of kit foxes is correlated with abundance of their prey (Egoscue 197[illegible]). Success decreases when the density of prey species drops because of drought, too much rainfall, or other circumstances (White and Ralls 1993, Spiegel et al. in press, B.L. Cypher pers. comm., White and Garrott 1998).

During a 6-year study at the Elk Hills Naval Petroleum Reserves in California, pups dispersed an average of 8 ± 1.4 kilometers (5.0 ± 0.9 mile; Scrivner et al. 1987*b*). Maximum reported distances can vary considerably (Hall 1983). One individual traveled a minimum of 40 kilometers (25 miles) from its whelping den (V. Getz pers. comm.), and a prime adult male dispersed from Camp Roberts to the Carrizo Plain in 1989 (P.J. White pers. comm.). Adult and juvenile kit foxes radio-collared at the Elk Hills Naval Petroleum Reserves in California dispersed through disturbed habitats, including agricultural fields, oil fields, rangelands, and across highways and aqueducts. One pup crossed the Temblor Range into the Carrizo Plain (Scrivner et al. 1987*b*).

The average age of kit foxes in a Utah population was about 2 years (Egoscue 1975). One fox in another Utah study was estimated to be at least 7 years old (Egoscue 1962). Kit foxes at Camp Roberts are reported to be over 8 years old (P.J. White pers. comm.). Kit foxes on Naval Petroleum Reserve-1 in California are known to live as long as 8 years but such longevity is rare; animals less than 1 year old outnumber older foxes by 2.8:1 (Berry et al. 1987*a*). Annual survival rates of juvenile foxes have ranged from 0.2[illegible] on Naval Petroleum Reserve-1 in California (Berry et al. 1987*a*) to 0.21 to 0.41 on the Carrizo Plain (Ralls and White 1995). In captivity, kit foxes have lived up to 10 years (McGrew 1979, M. Johnson pers. comm.).

An annual adult mortality rate of approximately 50 percent has been reported (Morrell 1972, Egoscue 1975, Berry et al. 1987*a*, Ralls and White 1995, Standley et al. 1992). The annual mortality rate for juvenile kit foxes may be closer to 70 percent (Berry et al. 1987*a*). Predation by larger carnivores (e.g., coyotes) accounts for the majority of San Joaquin kit fox mortality. The effects of disease, parasites and accidental death are largely unknown, but were thought to account for only a small portion of mortality (Berry et al. 1987*a*). Drought plays a role in low reproductive success (i.e., pups are born but do not survive to weaning). Adults can maintain weight and body condition and females can give birth, but pairs apparently cannot catch enough prey to support pups (White and Ralls 1993, Spiegel et al. in press).

San Joaquin kit fox densities on the west side of the

San Joaquin Valley were estimated to be 0.4 per square kilometer (1.04 per square mile) prior to 1925, based on fur trapping efforts (Grinnell et al. 1937). In 1969, Laughrin (1970) estimated that range-wide kit fox densities were 0.2 to 0.4 per square kilometer (0.52 to 1.04 per square mile). Morrell (1975) estimated densities of 1.2 per square kilometer (3.11 per square mile) in optimum habitats in "good" years. In the 1983 recovery plan (USFWS 1983), Morrell's data was corrected for habitat loss and an estimate of 0.5 per square kilometer (1.30 per square mile) was obtained. The estimated mean density of trappable adult kit foxes was from 0.8 to 1.1 per square kilometer (2 to 2.8 per square mile) between 1980 and 1982 on the Naval Petroleum Reserves in California (O'Farrell 1984). More recently, kit fox densities at the Naval Petroleum Reserves were determined from annual live-trapping efforts (Enterprise Advisory Services, Inc., unpubl. data). On Naval Petroleum Reserve-1 in California, the mean density from 1981 to 1993 was 0.12 per square kilometer (0.31 per square mile) in winter, but varied from 0.72 per square kilometer (1.86 per square mile) in 1981 to 0.01 per square kilometer (0.03 per square mile) in 1991. On Naval Petroleum Reserve-2 in California, mean density from 1983 to 1993 was 0.38 per square kilometer (0.98 per square mile), and varied from 0.72 per square kilometer (1.86 per square mile) in summer 1983 to 0.1 per square kilometer (0.30 per square mile) in winter 1991. On the nearby Carrizo Plain Natural Area, kit fox densities were estimated to be 0.15 to 0.24 per square kilometer (0.39 to 0.62 per square mile) (White and Ralls 1993).

In the 1983 recovery plan (USFWS 1983) it was estimated that the population range-wide of adult kit foxes prior to 1930 may have been between 8,667 and 12,134 assuming an occupied range of 22,447 square kilometers (8,667 square miles) and densities of 0.4 to 0.6 per square kilometer (1.04 to 1.55 per square mile). The kit fox population in San Luis Obispo, Santa Barbara, Kings, Tulare and Kern Counties was estimated to be about 11,000 animals in the early 1970s based on limited aerial surveys of pupping dens and amount of historic habitat, but without correction for cultivated and urbanized lands (Waithman 1974*b*). Laughrin (1970) reported an estimated total population size of 1,000 to 3,000 foxes in 1969. Morrell (1975) conducted a more thorough investigation of kit fox abundance in 14 counties in which kit foxes were known to occur and estimated the total population at 14,832. In the 1983 recovery plan (USFWS 1983), Morrell's data was adjusted and a corrected estimate of 6,961 foxes in 1975 was obtained. When compared to the pre-1930 estimate, this represents a possible population decline of 20 to 43 percent. Approximately 85 percent of the fox population in 1975 was found in only six counties (Kern, Tulare, Kings, San Luis Obispo, Fresno, and Monterey), and over half the population occurred in two of those counties: Kern (41 percent) and San Luis Obispo (10 percent) (Morrell 1975).

Behavior and Species Interactions.—San Joaquin kit foxes use dens for temperature regulation, shelter from adverse environmental conditions, reproduction, and escape from predators. Though kit foxes are reputed to be poor diggers (Jensen 1972, Morrell 1972), the complexity and depth of their dens do not support this assessment (USFWS 1983). Kit foxes also modify and use dens constructed by other animals, such as ground squirrels, badgers, and coyotes (Jensen 1972, Morrell 1972, Hall 1983, Berry et al. 1987*b*), and human-made structures (culverts, abandoned pipelines, and banks in sumps or roadbeds) (Spiegel et al. in press, B.L. Cypher pers. comm.).

Den characteristics vary across the San Joaquin kit fox's geographic range. In the southernmost portion, dens with two entrances are most frequently found. Natal and pupping dens, in which pups are born and raised, tend to be larger with more entrances (2 to 18) (Morrell 1972, O'Farrell and Gilbertson 1979, O'Farrell et al. 1980, O'Farrell and McCue 1981, Berry et al. 1987*b*). Entrances are usually from 20 to 25 centimeters (8 to 10 inches) in diameter and normally are higher than wide. Ramp-shaped mounds of dirt from 1 to 2 meters (3 to 6 feet) long are deposited at some den entrances (Morrell 1972). Most hillsides where kit fox dens are found (95 percent) have a slope of less than 40 degrees (Reese et al. 1992). Natal and pupping dens are found on flatter ground with slopes of about 6 degrees (O'Farrell and McCue 1981, O'Farrell et al. 1980). The entrances of pupping dens show more evidence of use, such as fox scat, prey remains, and matted vegetation. In the central portion of their geographic range, dens also have several openings; however, instead of a mound of dirt in front of the opening, the dirt is more often scattered into a long tailing ramp, generally with a runway down the middle. In areas of tall grass, matted grass in front of the entrance is obvious. In western Merced County, most dens are found on slopes of less than 10 degrees, but a few are found on slopes of up to 55 degrees (Archon 1992). In the northern portion of the kit fox range, dens appeared to be placed higher than most surrounding ground compared to areas farther south, perhaps reflecting the topography of the area. Dens most often are located on the lower section of the slope (Orloff et al. 1986), yet foxes are sometimes seen entering dens on the upper part of a slope (Bell 1992). Most dens lack the ramp or runway characteristic of dens in the southern and central portions of the Valley. No evidence has been found to indicate that kit foxes in this area construct their own dens (Hall 1983). Kit foxes probably enlarge California ground squirrel burrows (Orloff et al. 1986), but they also may construct their own dens.

Kit foxes often change dens and numerous dens may be used throughout the year. However, evidence that a den is in use may be absent (V. Getz pers. comm.). Reese et al (1992) found that 64 percent of the dens used by radio-collared kit foxes at Camp Roberts during 1988-1991 exhibited no sign of kit foxes. Foxes change dens four or five times during the summer months, and change natal dens one or two times per month (Morrell 1972). One family of 7 kit foxes used 43 dens; the maximum number used by 1 individual was 70 (Hall 1983). Foxes on the Carrizo Plain Natural Area changed dens much more frequently than indicated by Morrell's study (White and Ralls 1993). Radiotelemetry studies indicate that foxes use individual dens for a median of 2 days (mean of 3.5 days) before moving to a different den. One fox was tracked to 70 different dens during a two year study (K. Ralls pers. comm.). Den changes have been attributed to depletion of prey in the vicinity of the den or to increases in external parasites such as fleas (Egoscue 1956). Avoidance of coyotes is a more probable reason for frequently changing dens because kit foxes can easily search their home range in one night for prey, and parasites are unlikely to build to intolerable levels in 2 or 3 days (K. Ralls pers. comm.)

Nightly movements on the Elk Hills Naval Petroleum Reserves in California averaged 15.4 kilometers (9.6 miles) during the breeding season and were significantly longer than the average nightly movements of 10.2 kilometers (6.3 miles) during the pup-rearing season. Movements during the breeding season also were significantly longer than those made during the pup-dispersal season (10.4 kilometers, 6.5 miles) (Zoellick et al. 1987*b*).

Home ranges of from less than 2.6 square kilometers (1 square mile) up to approximately 31 square kilometers (12 square miles) have been reported by several researchers (Morrell 1972, Knapp 1978, Zoellick et al. 1987*b*, Spiegel and Bradbury 1992, White and Ralls 1993, Paveglio and Clifton 1988). The maintenance of large and relatively non-overlapping home ranges, as noted on the Carrizo Plain, may be an adaptation to drought-induced periods of prey scarcity that are episodic and temporary on the Carrizo Plain (White and Ralls 1993). Differences in home range size among study sites tend to be related to prey abundance (White and Ralls 1993, White and Garrott 1998).

Kit foxes are subject to predation or competitive exclusion by other species, such as the coyote, nonnative red foxes, domestic dog *(Canis familiaris)*, bobcat *(Felis rufus)*, and large raptors (Hall 1983, Berry et al. 1987*a*, O'Farrell et al. 1987*b*, White et al. 1994, Ralls and White 1995, CDFG 1987). Coyotes are known to kill kit foxes, though an experimental coyote-control program at the Elk Hills Naval Petroleum Reserves in California did not result in an increase in survival rate for kit foxes, nor did coyote-induced mortality decrease (Cypher and Scrivner 1992, Scrivner and Harris 1986, Scrivner 1987). The extent to which gray and kit foxes compete for resources is unknown. The need for similar den sites and prey species probably place nonnative red foxes in direct competition with the much smaller kit fox. Nonnative red foxes are expanding their geographic range in central California (Orloff et al. 1986, Lewis et al. 1993), and competition with or predation on kit foxes may be a factor in the apparent decline of kit foxes in the Santa Clara Valley (T. Rado pers. comm.), and perhaps elsewhere in the northwestern segment of their range. Coyotes aggressively dominate encounters with red foxes and will pursue and kill both red and gray foxes (Sargeant and Allen 1989), as well as kit foxes. Coyotes may reduce the negative impacts of red foxes on kit foxes by limiting red fox abundance and distribution, but details of interactions between the two species and the extent to which coyotes might slow or prevent the invasion of red foxes into kit fox habitats are unknown (White et al. 1994, Ralls and White 1995).

Activity Cycle.—San Joaquin kit foxes are primarily active at night (i.e., nocturnal), and active throughout the year (Grinnell et al. 1937, Morrell 1972). Adults and pups sometimes rest and play near the den entrance in the afternoons, but most above-ground activities begin near sunset and continue sporadically throughout the night. Morrell (1972) reported that hunting occurred only at night. Yet predation on ground squirrels, which are active during the day (i.e., diurnal), by some populations indicates that kit foxes are not strictly nocturnal, adapting to the activities of available prey (Balestreri 1981, Hall 1983, Orloff et al. 1986, O'Farrell et al. 1987*b*, Hansen in litt. 1988).

Habitat and Community Associations.—Kit foxes prefer loose-textured soils (Grinnell et al. 1937, Hall 1946, Egoscue 1962, Morrell 1972), but are found on virtually every soil type. Dens appear to be scarce in areas with shallow soils because of the proximity to bedrock (O'Farrell and Gilbertson 1979, O'Farrell et al. 1980), high water tables (McCue et al. 1981), or impenetrable hardpan layers (Morrell 1972). However, kit foxes will occupy soils with a high clay content, such as in the Altamont Pass area in Alameda County, where they modify burrows dug by other animals (Orloff et al. 1986).

Historically, San Joaquin kit foxes occurred in several native plant communities of the San Joaquin Valley. Because of extensive land conversions and intensive land use, some of these communities only are represented by small, degraded remnants today. Other habitats in which kit foxes are currently found have been extensively modified by humans. These include grasslands and scrublands with active oil fields, wind turbines, and an agricultural matrix of row crops, irrigated pasture, orchards, vineyards, and grazed annual grasslands (nonirrigated pasture). Other plant communities in the San Joaquin Valley providing kit fox habitat include Northern Hardpan Vernal Pool, Northern Claypan Vernal Pool, Alkali Meadow, and Alkali Playa. These are found as relatively small patches in scattered locations. In general, they do not provide good denning habitat for kit foxes because all have moist or waterlogged clay or clay-like soils. However, where they are interspersed with more suitable kit fox habitats they provide food and cover.

In the southernmost portion of the range, the kit fox is commonly associated with Valley Sink Scrub, Valley Saltbush Scrub, Upper Sonoran Subshrub Scrub, and Annual Grassland. Kit foxes also inhabit grazed grasslands, petroleum fields (Morrell 1971, O'Farrell 1980), urban areas (B. Cypher pers. comm.), and survive adjacent to tilled or fallow fields (Jensen 1972, Ralls and White 1991). In the central portion of the range, the kit fox is associated with Valley Sink Scrub, Interior Coast Range Saltbush Scrub, Upper Sonoran Subshrub Scrub, Annual Grassland and the remaining native grasslands. Agriculture dominates this region where kit foxes mostly inhabit grazed, nonirrigated grasslands, but also live next to and forage in tilled or fallow fields, irrigated row crops, orchards, and vineyards. In the northern portion of their range, kit foxes commonly are associated with annual grassland (Hall 1983) and Valley Oak Woodland (Bell 1994). Kit foxes inhabit grazed grasslands, grasslands with wind turbines, and also live adjacent to and forage in tilled and fallow fields, and irrigated row crops (Bell 1994).

Kit foxes use some types of agricultural land where uncultivated land is maintained, allowing for denning sites and a suitable prey base (Jensen 1972, Knapp 1978, Hansen 1988). Kit foxes also den on small parcels of native habitat surrounded by intensively maintained agricultural lands (Knapp 1978), and adjacent to dryland farms (Jensen 1972, Kato 1986, Orloff et al. 1986).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—Numerous causes of kit fox mortality have been identified, though these have probably varied considerably in relative importance over time. Researchers since the early 1970s have implicated predation, starvation, flooding, disease, and drought as natural mortality factors. Shooting, trapping, poisoning, electrocution, road kills, and suffocation have been recognized as human-induced mortality factors (Grinnell et al. 1937, Morrell 1972, Egoscue 1975, Berry et al. 1987*a*, Ralls and White 1991, Ralls and White 1995, Standley et al. 1992).

By the 1950s the principal factors in the decline of the San Joaquin kit fox were loss, degradation, and fragmentation of habitats associated with agricultural, industrial, and urban developments in the San Joaquin Valley (Laughrin 1970, Jensen 1972, Morrell 1975, Knapp 1978). Extensive land conversions in the San Joaquin Valley began as early as the mid-1800s with the Arkansas Reclamation Act, and by 1958 an estimated 50 percent of the Valley's original natural communities had been lost (USFWS 1980*a*). In recent decades this rate of loss has accelerated rapidly with completion of the Central Valley Project and the State Water Project, which diverted and imported new water supplies for irrigated agriculture (USFWS in litt. 1995*a*). From 1959 to 1969 alone, an estimated 34 percent of natural lands were lost within the then-known kit fox range (Laughrin 1970). By 1979, only about 6.7 percent of the San Joaquin Valley floor's original wildlands south of Stanislaus County remained untilled and undeveloped (USFWS 1980*a*).

Such land conversions contribute to kit fox declines through displacement, direct and indirect mortalities, and reduction of prey populations.

Threats to Survival.—Loss and degradation of habitat by agricultural and industrial developments and urbanization continue, decreasing carrying capacity of remaining habitat and threatening kit foxes. Livestock grazing is not thought to be detrimental to kit foxes (Morrell 1975, Orloff et al. 1986), but may alter the numbers of different prey species, depending on the intensity of the grazing. Livestock grazing may benefit kit foxes in some areas (Laughrin 1970, Balestreri 1981), but grazing that destroys shrub cover and reduces prey abundance may be detrimental (O'Farrell et al. 1980, O'Farrell and McCue 1981, USFWS 1983, Kato 1986).

Petroleum field development in the southern half of the San Joaquin Valley affects kit foxes by habitat loss due to grading and construction for roads, well pads, tank settings, pipelines, and settling ponds. Habitat degradation derives from increased noise, ground vibrations, venting of toxic and noxious gases, and release of petroleum products and waste waters. Traffic-related mortality is also a factor for kit foxes living in oil fields. The cumulative and long-term effects of these activities on kit fox populations are not fully known, but recent studies indicate that areas of moderate oil development may provide good habitat for kit foxes, as long as suitable mitigation policies are observed (O'Farrell et al. 1980, Spiegel et al. in press). The impacts of oil activities at the Elk Hills Naval Petroleum Reserves in California on kit fox population density, reproduction, dispersal, and mortality appeared to be similar in developed and undeveloped areas of the Reserve (Berry et al. 1987*a*). The most significant impact on kit fox abundance in developed oil fields appears to be mediated through habitat loss. However, the relationship between habitat loss and population size in western Kern County is unclear: the Midway-Sunset oil field is highly developed with about 70 percent ground disturbance yet fox abundance is about 50 percent that of the undeveloped Lokern area (Spiegel et al. in press).

Other developments within the kit fox's range include cities and towns, aqueducts, irrigation canals, surface mining, road networks, non-petroleum industrial projects, power lines, and wind farms. These developments negatively impact kit fox habitat, but kit foxes may survive within or adjacent to them given adequate prey base and den sites. Kit foxes have been documented denning along canals and in levees (Jones and Stokes 1981, Hansen 1988), adjacent to highways (ESA Planning and Environmental Services 1986*b*, Hansen 1988), near wind farms (Hall 1983, Orloff et al. 1986), along power line corridors (Swick 1973), and at sanitary land fills (R. Faubion pers. comm.). Kit foxes also are known to live in and adjacent to towns such as Tulare (G. Presley pers comm.), Visalia (Zikratch pers. comm.), Porterville (Hansen 1988), Maricopa, Taft, and McKittrick (J.M. Sheppard pers. comm.) and the City of Bakersfield (Jones and Stokes 1981, B.L. Cypher pers. comm.). Bakersfield foxes (living in the Kern River Parkway) are reported to behave differently from animals in more remote populations: they often scavenge food from parking lots and dumpsters, have small foraging ranges, often are diurnal, and are relatively tame. This may be an expression of their ecological plasticity (e.g., Grinnell et al. 1937, p. 411, T. Murphy pers. comm., B.L. Cypher pers. comm.).

All these influences combine to compress and constrict the kit fox into fragmented areas, varying in size and habitat quality. The fragmentation of these areas coupled with the suspected high mortality during dispersal may limit movement to and habitat of these lands. As the human population of California continues to grow, the amount and quality of habitat suitable for kit foxes will inevitably decrease. Continued habitat fragmentation is a serious threat to the survival of kit fox populations.

The use of pesticides and rodenticides also pose threats to kit foxes. Pest control practices have impacted kit foxes in the past, either directly, secondarily, or indirectly by reducing prey. In 1925, near Buena Vista Lake, Kern County, seven kit foxes were found dead within a distance of 1 mile, having been killed by strychnine-poisoned baits put out for coyotes. It was suspected that hundreds of kit foxes were similarly destroyed in a single season (Grinnell et al. 1937). In 1975 in Contra Costa County (where the main prey item of kit foxes is the California ground squirrel), the ground squirrel was thought to have been eliminated county wide after extensive rodent eradication programs (Bell et al. 1994). In 1992, two kit foxes at Camp Roberts died as a result of secondary poisoning from rodenticides (Berry et al. 1992, Standley et al. 1992). The Federal government began controlling the use of rodenticides in 1972 with a ban of Compound 1080 on Federal lands pursuant to Executive Order. Above-ground application of strychnine within the geographic ranges of listed species was prohibited in 1988. Efforts have been underway to greatly reduce the risk of rodenticides to kit foxes (USFWS in litt. 1993).

Invasion and occupation of historical and potential kit fox habitats by nonnative red foxes may limit opportunities for kit foxes. Exclusion of kit foxes by competing red foxes, direct mortality, and potential for disease and parasite transmission all are issues that have not yet been researched. Therefore, we know neither the historical impacts to the kit fox, nor to what extent the continuing expansion of the range of nonnative red foxes will have on kit foxes.

Accidents and disease, though not well documented, are thought to play a minor role in kit fox mortality (USFWS 1983), however, at Camp Roberts rabies accounted for 6.3 percent of deaths of radio-collared kit foxes (Standley et al. 1992) and there is concern that rabies may be a contributing factor in the recent decline of kit foxes at Camp Roberts (P.J. White pers. comm.). Random catastrophic events such as drought or flooding present a significant threat. Drought, with a corresponding decline in prey availability, results in a decrease in kit fox reproductive success (White and Ralls 1993, Spiegel et al. in press). How extended periods of drought may affect kit fox populations is unclear, but local extinctions are likely in some isolated areas. Recently, small mammal populations have declined rapidly and severely, apparently due to the above average rainfall in the 1994-1995 precipitation year. In the Elk Hills region, relatively few pupping dens were found in 1995, and only a small proportion of kit fox pairs apparently raised pups (B.L. Cypher pers. comm., L.K. Spiegel pers. comm.).

5. Conservation Efforts

The San Joaquin kit fox was listed as endangered by the U.S. Department of the Interior in 1967 (USFWS 1967) and by the State of California in 1971 (Table 1). A recovery plan approved in 1983 proposed interim objectives of halting the decline of the San Joaquin kit fox and increasing population sizes above 1981 levels (USFWS 1983).

Conservation efforts subsequent to the 1983 recovery plan have included habitat acquisition by USBLM, CDFG, California Energy Commission, Bureau of Reclamation, USFWS, and The Nature Conservancy. Purchases most significant to conservation efforts were the acquisitions in the Carrizo Plain, Ciervo-Panoche Natural Area, and the Lokern Natural Area. A multi-agency acquisition is underway which would secure 60,000 acres straddling western Merced, Stanislaus, and eastern Santa Clara Counties. Other lands have been acquired as mitigation for land conversions, both temporary and permanent (Table 2). Mitigation in the form of management and research was granted to the California Energy Commission, U.S. Department of Energy (Naval Petroleum Reserves in California), Army National Guard (Camp Roberts), and Department of Defense (Fort Hunter Liggett). Most of the current research literature arises from these sources and The Smithsonian/Nature Conservancy-sponsored research on the Carrizo Plain Natural Area (White and Ralls 1993, White et al. 1994, Ralls and White 1995, White et al. 1996).

For over 15 years EG&G Energy Measurements has conducted research into the ecology of the kit fox population on the Naval Petroleum Reserves in California, Kern County. Reports have covered such topics as dispersal (Scrivner et al. 1987*b*), mortality (Berry et al. 1987*a*), and movements and home range (Zoellick et al. 1987*b*). Additionally, they have evaluated habitat enhancement, kit fox relocation, supplemental feeding (EG&G Energy Measurements 1992), and coyote control (Cypher and Scrivner 1992) as means of enhancing recovery. Other life history information has come from studies sponsored in whole or in part by CDFG, California Department of Water Resources, USFWS, Smithsonian Institution, Department of the Army and Air Force, California Energy Commission, and The Nature Conservancy (Hall 1983, Archon 1992, Spiegel and Bradbury 1992, White and Ralls 1993, White et al. 1994, 1996). Following the 1983 recovery plan, only three surveys for distribution have been conducted, two in the northern range of the fox (Orloff et al. 1986, Bell et al. 1994), and one in western Madera County (Williams 1990).

Large-scale habitat surveys have been conducted on the Carrizo Plain (Kato 1986, Kakiba-Russell et al. 1991) and the southern San Joaquin Valley (Anderson et al. 1991). A preliminary aerial survey for potential habitat was conducted along the east side of the Valley (Bell et al. 1994). There also have been numerous smaller-scale preproject surveys as part of the section 7 and 10(a) permit process of the Endangered Species Act, National Environmental Protection Act, and California Environmental Quality Act laws and regulations.

A population viability analysis was prepared for USFWS using RAMAS/a, a Monte Carlo simulation of the dynamics of age-structured populations (Buechner 1989). Since this analysis, deficiencies in the database have been identified and a metapopulation analysis has been completed (Kelly et al. 1995). This analysis, however, is preliminary and will be updated as new information is collected.

The U.S. Environmental Protection Agency County Bulletins governing use of rodenticides have greatly reduced the risk of direct mortality to San Joaquin kit fox populations by State and county rodent-control activities. The California Environmental Protection Agency, California Department of Food and Agriculture, county agricultural departments, CDFG, and U.S. Environmental Protection Agency collaborated with the USFWS in the development of County Bulletins that are both efficacious and acceptable to land owners (R.A. Marovich pers. comm.).

6. Recovery Strategy

Though the kit fox has been listed for over 30 years, its status throughout much of its current range is poorly known. This is partly because so much of its historical range in the San Joaquin Valley is in private ownership. Similar gaps in information are common to many of the other listed and candidate species being addressed in this recovery plan. However, recovery actions for the kit fox are also considered critical to the recovery of many of these other species in the San Joaquin Valley. The kit fox's occurrence in the same natural communities as most other species featured in this plan and its requirement for relatively large areas of habitat mean its conservation will provide an umbrella of protection for many of those other species that require less habitat. Therefore, a conservative recovery strategy is appropriate for this species and the following regional (or ecosystem level) recovery actions should be given high priority.

Given the importance and urgency of the situation, the recovery strategy for the kit fox needs to operate on two distinct but equally important levels: the continuation and expansion of recovery actions initiated subsequent to the original recovery plan using existing information; and, the development of new information in concert with expansion of existing information, which is currently inadequate for some aspects of recovery management.

Level A Strategy.—The goal of this strategy is to work toward the establishment of a viable complex of kit fox populations (i.e., a viable metapopulation) on private and public lands throughout its geographic range. Although the exact dimensions of a viable kit fox metapopulation cannot be predicted in advance, there are general principles from conservation biology that can and must be applied for recovery of the San Joaquin kit fox (with due consideration to the current, inadequate knowledge about the animal's life history, distribution, and status). Because kit foxes require large areas of habitat and have dramatic, short-term population fluctuations, one cannot rely on a single population to achieve recovery. Preliminary population viability analyses suggest that the Carrizo Plain population, the largest remaining, is not viable by itself nor is it viable in combination with populations in western Kern County and the Salinas Valley.

Conserving a number of populations, some much more significant than others because of their large sizes or strategic locations, therefore, will be a necessary foundation for recovery. The areas these populations inhabit need to encompass as much of the environmental variability of the historical range as possible. This will ensure that maximal genetic diversity is conserved in the kit fox metapopulation to respond to varying environmental conditions, and that one environmental event does not negatively impact to the same extent all existing populations. Also, connections need to be established, maintained, and promoted between populations to counteract negative consequences of inbreeding, random catastrophic events (e.g., droughts) and demographic factors.

A sound, conservative strategy hinges on the enhanced protection and management of three geographically-distinct core populations, which will anchor the spine of the metapopulation. A number of smaller satellite populations (number and location yet to be determined, probably 9 to 12 or more) will be fostered in remaining fragmented landscapes through habitat management on public land and conservation agreements with private land owners.

The three core populations are:

1. Carrizo Plain Natural Area in San Luis Obispo County;
2. Natural lands of western Kern County (i.e., Elk Hills, Buena Vista Hill, and the Buena Vista Valley, Lokern Natural Area and adjacent

natural land) inhabited by kit foxes; and

3. The Ciervo-Panoche Natural Area of western Fresno and eastern San Benito Counties.

These three core populations each are distinct. The western Kern County and Carrizo Plain populations, although geographically close, are separated by the Temblor Range. Although both locations have high fox densities from time to time, they also have different environmental conditions, which are reflected in the fact that their population dynamics are not always synchronous (B.L. Cypher pers. comm., Endangered Species Recovery Program unpubl. observ.). These differences amongst the core populations are important considerations in conservation planning. Also, preliminary population viability analyses indicate that extinction probabilities increase dramatically if either the Carrizo Plain or western Kern County population is eliminated. Finally, both of these locations have large amounts of land in public ownership, lowering the burden on private land owners to assist in recovery of the kit fox. The Carrizo Plain and western Kern County populations are important for kit fox recovery.

The Ciervo-Panoche Natural Area population is located more than 160 kilometers (100 miles) northwest of the other two core populations. As with the other core populations, it has significant numbers of foxes, at least it had historically and it still may from time to time, and large expanses of land are in public ownership. It also experiences a different environmental regime from the other two. Finally, preliminary metapopulation viability analyses indicate that recovery probabilities increase if a population is established or maintained in this area, apparently because of its different environmental regime.

In addition to basing the choice of these three core populations on the above criteria, this particular metapopulation configuration has an additional important advantage over combinations of other fox populations. These three populations are more or less connected to each other by grazing lands, although they are steep and rugged in many places. Kit foxes occur at varying densities in the areas between the core populations (e.g., Kettleman Hills), providing linkages between core populations, and also probably with smaller, more isolated populations in adjacent valleys.

Important kit fox populations in the Salinas-Pajaro Region (herein defined as the area of the Salinas River and Pajaro River watersheds with habitat for kit foxes; Figs. 1 and 51) are located at Camp Roberts and Fort Hunter Liggett in the Salinas River Watershed. Though there are natural connections between the Salinas-Pajaro Region, the Carrizo Plain Natural Area, and the San Joaquin Valley, the amount of movement of kit foxes between the Salinas-Pajaro Region and these areas is unknown, though one fox is known to have moved from Camp Roberts to the Carrizo Plain (K. Ralls pers. comm.).

Other lands in the San Joaquin Valley that have kit foxes, or the potential to have them, include refuges and other lands managed by the CDFG, California Department of Water Resources, Center for Natural Lands Management, Lemoore Naval Air Station, Bureau of Reclamation, and USFWS, as well as those on private lands in western Madera County, central, western, and eastern Merced County, eastern Stanislaus County, northern Kings County, around Pixley National Wildlife Refuge and Allensworth Ecological Reserve in Tulare County, Semitropic Ridge Natural Area and around the Bakersfield metropolitan area of Kern County (Figure 51).

Many of these more isolated natural lands exhibit symptoms of ecosystem fragmentation such as degradation of natural communities and loss of biodiversity. Nevertheless, some fragments have resident kit foxes by virtue of their proximity to other populations, and others serve as important corridors between kit fox populations. For example, the California Department of Water Resources's Kern Fan Element provides an important linkage between kit foxes along the Kern River Parkway in Bakersfield and the western Kern County core population.

Yet, many of these areas, despite having suitable habitat, have become so degraded over time, reduced in size, and isolated from extant kit fox populations that they rarely have kit foxes today. When they do, these small, isolated populations are very susceptible to local extinction. It is likely that the degree of isolation from larger, more stable kit fox populations is the primary reason for absence or very low densities of kit foxes on some of the larger parcels of natural land remaining on the Valley floor (e.g., central Merced County, western Madera County, and the Mendota area, Fresno County; Williams 1990).

Connecting larger blocks of isolated natural land to core and other populations, thus, is an important element of recovery of kit foxes. Connecting large blocks will help reduce the harmful effects of habitat loss and fragmentation. To enhance these connections, conservation lands on the Valley floor could be increased in size through acquisition of title or conservation easements, or a combination of both.

Another complementary approach is to reduce the level of isolation by promoting conservation of kit foxes on agricultural lands through "safe harbor" and other initiatives. New procedures and regulations must ensure that farmers are not penalized and farming not disrupted by enhancing use of farmland by kit foxes. The goal should be specific incentive programs to encourage farmers to maintain, enhance, or create habitat conditions for kit foxes. The ideal situation would be to establish a small number of breeding kit foxes in farm lands. A proposal to address habitat fragmentation in this way has already been developed by the American Farmland Trust (Scott-Graham 1994). Those lands could then serve as bridges between the more isolated refuges and reserves and the larger populations along the spine of the metapopulation, on the west side of the San Joaquin Valley.

Concurrently, strategic retirement of agricultural lands that have serious drainage problems will help reduce the effects of widespread habitat fragmentation of populations. Land retirement for reducing or eliminating drainage problems has been authorized by both State and Federal governments. In particular, the Central Valley Project Improvement Act of 1992 has provisions and funding for such land retirement. If land retirement proves not to pose a contaminant issue, the program can greatly boost recovery of kit foxes and other listed species and species of concern in the San Joaquin Valley. If large blocks (ideally, no less than 2,023 to 2,428 hectares [5,000 to 6,000 acres]) of drainage-problem lands are retired from irrigated agriculture, the retired farmland can be converted to habitat for kit foxes, kangaroo rats, blunt-nosed leopard lizards, and other listed and sensitive species. Those land blocks can provide more than just habitat. They can also reduce isolation and its detrimental effects. If strategically located, they can provide "stepping stones" for movement of kit foxes between Valley floor and west side populations. Strategic irrigated land retirement and subsequent establishment as habitat conservation areas is the most cost effective and rapid route to recovery of kit foxes.

Level B Strategy.—While land retirement and habitat restoration and management get under way, other urgent recovery needs, which are primarily research-related or informational in nature, must be addressed. The acquisition of new and better information will permit refinement of the viability models and land-use optimization models that are under development for the kit fox. In turn these models will assist in management of kit fox populations.

Needed is information on distribution and status throughout most of its current and historical range. Much better information on the distribution, status and movements of kit foxes is needed, particularly in the Salinas-Pajaro Region and the northern and eastern San Joaquin Valley.

Good data also are needed on the use of agricultural lands by kit foxes. Better demographic information is needed for kit foxes living in natural, agricultural, residential, and industrial lands throughout their range. Most of the existing data are for the southern part of the Valley where the environmental regime is more arid, and destruction of former fox habitat has been much more recent. Better data on the relationship between prey populations and kit fox population dynamics also are needed. A better understanding is needed of how kit foxes interact with red foxes, the indirect impacts of rodenticide use, and the influence of predator control activities.

Recovery Actions.—Recognizing that recovery requires a dual track with simultaneous actions, recovery actions are ordered in two lists, each of approximately equal priority to the other: a) habitat protection and population interchange, and, b) population ecology and management. Habitat protection and enhancement requires appropriate land use and management. To do so often requires purchase of title or conservation easement, or another mechanism of controlling land use. However, until needed research is completed, if listed species occur on an acquired parcel, the general rule of thumb should be that no dramatic changes in land use be made until appropriate management prescriptions have been determined. Many elements of management must first be determined by scientific research; thus the concept of adaptive management (monitoring and evaluating outcomes, then readjusting management directions accordingly) is operative here. A high priority therefore is the research required to determine appropriate habitat management and other recovery actions.

a. Habitat Protection and Population Interchange:

i. Protect natural lands in western Kern County.

ii. Protect natural lands in the Ciervo- Panoche Natural Area of western Fresno and eastern San Benito Counties.

iii. Expand and connect existing refuges and reserves in the Pixley-Allensworth and Semitropic Ridge natural areas through acquisition of existing natural land and farmland with drainage problems, and by safe harbor initiatives.

iv. Expand and connect (physically or by "stepping stones") existing natural land in the Mendota area, Fresno County, with the Ciervo-Panoche Natural Area, through restoration of habitat on retired, drainage-problem farmland.

v. Maintain and enhance connecting corridors for movement of kit foxes between the Kettleman Hills and the Valley's edge through the farmed gap between the Kettleman and Guijarral Hills, and between the Guijarral Hills and Anticline Ridge.

vi. Maintain and enhance connecting corridors for movement of kit foxes around the western edge of the Pleasant Valley and Coalinga in Fresno County, and between this area and natural lands on the western edge of the Coastal Range in Kings and Kern Counties.

vii. Maintain and enhance movement of kit foxes through agricultural land between the Lost Hills area and the Semitropic Ridge Natural Area by strategic retirement of drainage-problem farmland, acquisition, and safe harbor initiatives.

viii. Maintain and enhance habitat and movement corridors around the south end of the Valley between the Maricopa area on the west and Poso Creek area on the northeast through easements, zoning agreements, and safe harbor initiatives. One south Valley component is already in place. Kern Fan Element provides valuable conservation lands that serve as an important bridge between the Bakersfield area and the Elk Hills-Lokern core area. This design is being maintained by the new project owners, the Kern Water Bank Authority.

ix. Maintain and enhance movement of kit foxes between the Mendota area, Fresno County, natural lands in western Madera County, and natural lands along Sandy Mush Road and in the wildlife refuges and easement lands of Merced County. Specifically, maintain and enhance the Chowchilla or Eastside Bypass and natural lands along this corridor through acquisition, easement, or safe harbor initiatives.

x. Link natural lands in the Sandy Mush Road area of Merced County with the population of kit foxes on natural lands to the east by a safe harbor initiative on farmland.

xi. Protect natural land on the eastern base of Ortigalita Mountain and maintain and enhance a potential movement corridor through farmland between the base of Ortigalita Mountain, Merced County, and natural land to the north along the edge of the Diablo Range through Santa Nella by zoning and cooperative safe harbor initiatives.

xii. Protect and enhance existing kit fox habitat in the Salinas-Pajaro Region, centered on Camp Roberts and Fort Hunter Liggett.

xiii. Protect and enhance corridors for movement of kit foxes through the Salinas-Pajaro Region and from the Salinas Valley to the Carrizo Plain and San Joaquin Valley.

xiv. Protect existing kit fox habitat in the northern, northeastern, and northwestern segments of their geographic range and existing connections between habitat in those areas and habitat farther south.

b. Population Ecology and Management:

i. Determine habitat restoration and management prescriptions for kit foxes. Such studies should focus on factors that promote populations of prey species, including several that are included in this recovery plan. Appropriate habitat management for those species is one of the highest priority issues in their recovery, and thus, indirectly in recovery of kit foxes.

ii. Determine current geographic distribution and population status of kit foxes, with special emphasis on potential habitat in eastern Madera, Merced, Stanislaus, and San Joaquin Counties and the Salinas-Pajaro Region.

iii. Establish a scientifically valid population monitoring program range-wide at representative sites, and periodically monitor the status of these populations.

iv. Determine use of farmland by kit foxes. Studies should determine types of crops and cultural practices providing foraging habitat; structures and landscape features providing denning opportunities and promoting movement of kit foxes through agricultural land and between natural and agricultural land; demography of kit foxes in agricultural land; and red fox/kit fox interactions in an agricultural setting (the latter topic is discussed further in a subsequent action).

v. Measure population movements between the three core areas and the Salinas-Pajaro Region through genetic investigations and expansion and coordination of existing population studies. Ongoing studies at Elk Hills (Naval Petroleum Reserve #2 in California - U.S. Department of Energy and its contractors, and Occidental of Elk Hills - Occidental Petroleum), Fort Hunter Liggett (U.S. Army), Camp Roberts (CA Army National Guard), and the Panoche Region (Endangered Species Recovery Program, USFWS, Bureau of Reclamation), should be expanded and their objectives redefined and coordinated. An additional population study should be initiated on the Carrizo Plain Natural Area and coordinated with these other studies. Important common objectives of all studies should be: population estimates applicable to each region and not just the facility (e.g., western Kern County, Salinas-Pajaro Region); dispersal distance and success; fluctuations in vital rates and spatial parameters of populations compared to environmental fluctuations (i.e., population demography, including reproduction, mortality, survivorship, recruitment into the population and dispersal); and interactions of canid species (i.e., kit foxes, red foxes, coyotes, free-ranging dogs).

vi. Determine direct and indirect effects of rodent and rabbit control programs on kit foxes, and the economic costs and benefits of control programs versus kit fox enhancement programs for controlling ground squirrels and rabbits.

vii. Measure genetic features and degree of isolation of agricultural "island" populations and effective population movement between core populations using DNA techniques.

viii. Determine the nature of interactions between kit foxes, red foxes, coyotes, and free-ranging dogs on both farmland and grazing land. One element of this study should be to determine which fox species benefits more from enhancement of farmland habitat for wildlife, and what this means to survival of kit fox populations in farmland. Another element should be to determine if coyote control benefits red foxes to the detriment of kit foxes.

M. STATE LISTED, FEDERAL CANDIDATES AND OTHER ANIMAL SPECIES OF CONCERN

1. Dune Community Insects

Three species of sand-dwelling beetles are not candidates for listing, but are of special interest. Though each has a different pattern of distribution, all occur in similar, rare habitats in the northwestern portion of the San Joaquin Valley. There are several common elements in their recovery, particularly protecting their habitats and learning more about distribution, life history, and population status. First, individual accounts are presented, then a composite conservation strategy is presented for them and their supporting biotic communities.

a. Ciervo Aegialian Scarab Beetle (*Aegialia concinna*)

Taxonomy.—The Ciervo aegialian scarab beetle (*Aegialia concinna*) was described by Gordon and Cartwright (1977) from the type locality 29 kilometers (18 miles) southwest of Mendota, Fresno County, California. This beetle is a member of the Order Coleoptera, the Family Scarabaeidae, Subfamily Aphodiinae, and Tribe Aegialiini (Gordon and Cartwright 1988).

Description.—The Ciervo aegialian scarab beetle is a flightless, pale brownish-yellow to reddish-brown beetle, with the upper surface always paler than the underparts (Figure 52). This beetle ranges in length from 3.25 to 4.0 millimeters (0.13 to 0.15 inch), and from 1.70 to 2.0 millimeters (0.07 to 0.08 inch) in width (scientific measurement of insects is universally in metric units).

The small size, pale color, and slender, smooth hind legs distinguish the Ciervo Aegialian scarab beetle from others in the same genus (Gordon and Cartwright 1977, 1988).

Historical and Current Distribution.—The Ciervo aegialian scarab beetle is known from only four localities in Contra Costa, Fresno, and San Benito Counties (Gordon and Cartwright 1988), and San Joaquin County (USFWS in litt. 1992*a*) (Figure 53).

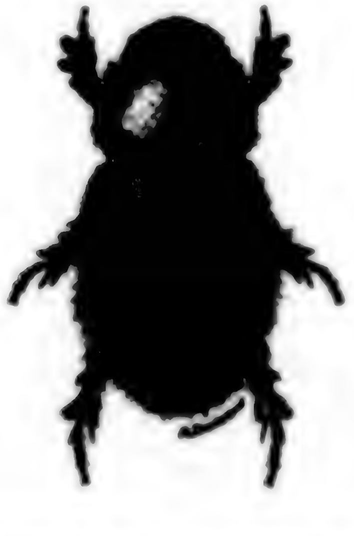

Fig. 52. Drawing of the Ciervo aegialian scarab beetle (*Aegialia concinna*). Adapted from Gordon and Cartwright, 1977.

Life History and Habitat.—Little is known about the specific life history and habitat of the Ciervo aegialian scarab beetle. In general, beetles of the Family Scarabaeidae, Subfamily Aphodiinae, eat dung and other decaying organic materials. Most adults tunnel and form a dung ball underground for larva. Some larvae live in soil or sand, feeding on organic materials or plant roots (White 1983). The Ciervo aegialian scarab beetle has been associated with Delta and inland dune systems, and sandy substrates (Gordon and Cartwright 1988, Miriam Green Associates 1993). Plant associations specific to this species are unknown.

Reasons for Decline and Threats to Survival.—Suitable habitats for species associated with dune systems in the San Joaquin Valley are limited and highly fragmented. Dune systems have been destroyed or severely degraded by agricultural development, flood control, water management, and off-road vehicle use (Gordon and Cartwright 1977, Miriam Green Associates 1993). As a result, populations of the Ciervo aegialian scarab beetle are locally isolated, making them highly vulnerable to disturbances.

b. San Joaquin Dune Beetle (*Coelus gracilis*)

Taxonomy.—The genus *Coelus* Eschscholtz, 1829, of the family Tenebrionidae (Coleoptera, Tentyriinae) includes five species of burrowing beetles that are mostly restricted to sand dunes in western coastal states of North America. The San Joaquin dune beetle (*Coelus gracilis*) was described by Blaisdell (1939) from the specimen type collected near Antioch, Contra Costa County, California.

Description.—The San Joaquin dune beetle is the smallest species (average body length) of dune beetles, with the male beetle averaging about 85 percent the size of the female (Doyen 1976). In general, the body is sturdy, inflated on top, and ranges in color from pale yellowish-brown to dark brownish-black (Figure 54).

Historical and Current Distribution.—The San Joaquin dune beetle historically inhabited inland sand dunes from Antioch, Contra Costa County, in the north to the Kettleman Hills, Kings County, in the south (Figure 53) (Doyen 1976). Currently, this beetle is restricted to small isolated sand dunes (250 to 10,000 square meters; 275 to 11,000 square yards) along the western edge of the

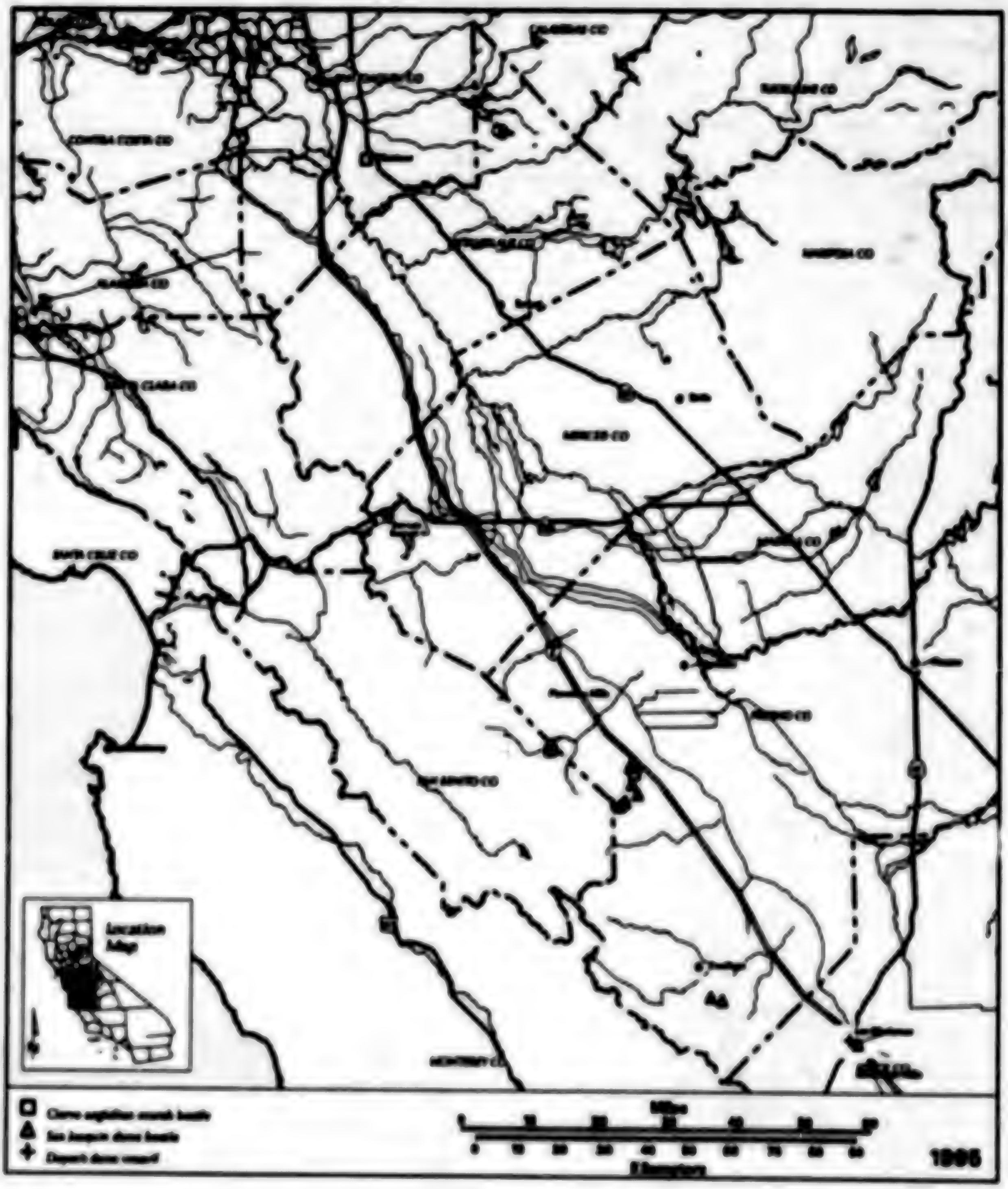

Figure 53. Distributional records for three species of sand dune inhabiting beetles in the San Joaquin Valley, California.

San Joaquin Valley. The population at the type locality near Antioch, Contra Costa County, apparently has been eliminated (Doyen 1976, USFWS 1978, in litt. 1992*a*, 1992*b*).

Life History and Habitat.—The San Joaquin dune beetle is believed to be a *detritivore*, feeding upon decomposing vegetation buried in the sand (Scarabeus Associates 1989). Nothing is known about the mating system of the San Joaquin dune beetle. In general, eggs of beetle species develop in the ovaries of the female and may be laid singly or in masses, with hatching occurring after several days (White 1983). Larval dune beetles, including very small larvae, are common throughout the year, indicating that oviposition (*i.e.*, egg laying) occurs over a long period of time. Dune beetle larvae develop and pupate exclusively in the sand. Pupae have been found in the wild only in late spring and early summer (Doyen 1976). The San Joaquin dune beetle resides in a hot summer climate, and is active from about November through April, during the growth period of the winter short-lived plants under which it takes refuge. Few San Joaquin dune beetles are found during summer months (Doyen 1976). Adult dune beetles may live at least 6 months in the laboratory, and for a year or longer in the wild (Doyen 1976).

San Joaquin dune beetles spend most of their time in sand soils. Larval stages are found exclusively in loose sands. Adults typically reside 5 to 10 centimeters (2.0 to 4 inches) or more underground under a canopy of vegetation. Less often they are found underground in areas with no vegetation covering the surface. Their occurrence in favorable habitats is very patchy (Doyen 1976).

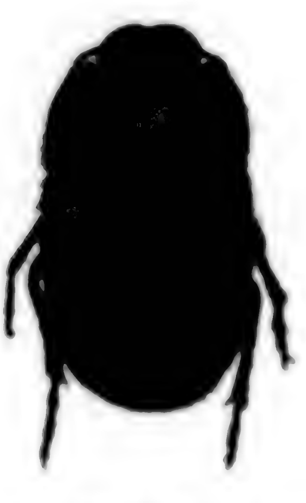

Figure 54. Illustration of San Joaquin dune beetle (by Kristina Bocchini, © by CSU Stanislaus Foundation).

Reasons for Decline and Threats to Survival.—There is no evidence that this species has declined, though it may be inferred so from the widespread loss of sand dune communities in the San Joaquin Valley (Gordon and Cartwright 1977) and apparent disappearance from the type locality (Doyen 1976). Doyen (1976) believed that off-road vehicle use on dune habitats near Kettleman City and Monocline Ridge, Fresno County, was a threat to the species, though Hagen (1986) believed the disappearance of these beetles from Antioch Dunes was due to over-stabilization or lack of sufficient disturbance of the dunes.

c. Doyen's Dune Weevil
(*Trigonoscuta* sp.)

Taxonomy.—The primary reference on the taxonomy of the genus *Trigonoscuta* (sand dune weevils; Coleoptera, Curculionidae) is the posthumously-published work of Pierce (1975). Pierce's work describes some 65 species and places the genus close in evolution to the genus *Tapinopsis*, a group of flightless sand dune weevils from Chile. This judgment, based largely on the congruence of certain internal characteristics, upsets the accepted classification for these groups (Lacordaire 1863); it also places *Tapinopsis* as ancestral to *Trigonoscuta*. The numerous species in the genus probably result from the separation and isolation of small populations of these weevils by the advance, retreat, and evolution of ancient and modern coast lines and their associated dune and relict dune systems (Pierce 1975).

The Doyen's dune weevil, a species of *Trigonoscuta*, has not been formally described (E.L. Sleeper pers. comm.). It appears to be more closely related to coastal than to desert species (E.L. Sleeper pers. comm.). Sleeper (pers. comm.) has suggested the name "*Trigonoscuta doyeni*," but until it is formally described and named, it is not a recognized species.

Description.—Like all members of the genus, Doyen's dune weevils are flightless, and fit the general description given by Pierce (1975) as "gray, sand-colored, oval weevils," but are slightly lighter in color than other, coastal species (E.L. Sleeper pers. comm.). They range from 4.5 millimeters to 7 millimeters (0.18 to 0.27 inch) in length (Figure 55).

Historical and Current Distribution.—All *Trigonoscuta* species are associated with either coastal sand dunes, desert sand dunes, or other inland sand dune areas. Most inland species of the genus are found in the desert Southwest. However, in the early 1960s, Dr. Ellbert L. Sleeper discovered a population of sand dune weevils on a single sand dune in the Los Medanos area, just south of Kettleman Station in Kings County (Figure 53). The same population was independently discovered several years later by Dr. John T. Doyen of the Department of Entomological Sciences, University of California, Berkeley (E.L. Sleeper pers. comm.). Since that time, extensive surveys by several parties at over 30 sand-dune sites where the species might be expected to occur, between Kettleman Station in the south and the Panoche Hills in the north, have failed to locate another population (E.L. Sleeper pers. comm.).

Based on the negative results of these surveys, and the following additional points, it is unlikely that this wingless beetle has had a significantly wider distribution in the recent past. First, many species of *Trigonoscuta* are found in naturally isolated sand dune areas, just above the high tide zone along the Pacific Coast, from Victoria, British Columbia south to Baja California (Pierce 1975). Second, these weevils are flightless and restricted to sparsely vegetated, unconsolidated dunes found from the western San Joaquin Valley to the Mojave desert and Coachella and Imperial Valleys. This wide distribution of the many inland representatives of the genus suggests that they each evolved from ancestral coastal species isolated by the retreat of the ocean from the Central Valley and interior desert areas about 3 million years ago (Pierce 1975). Third, small, isolated populations are characteristic of this lineage, probably because of its evolutionary history (Pierce 1975). Fourth, by various accounts, sites in the central interior coast ranges of California with suitably loose sand dunes seem to be few in number, widely scattered, and of a tenuous, transitory nature—over time, some become consolidated and overgrown with vegetation, while others open up due to some local disturbance (Scarabaeus Associates 1989, E.L. Sleeper pers. comm.).

Figure 55. Illustration of Doyen's dune weevil (by Kristina Bocchini, © CSU Stanislaus Foundation).

According to Sleeper (pers. comm.), this solitary population of *Trigonoscuta* is found on the open "slip-face," covering about 200 square meters (240 square yards) of a modified, vegetated relict dune. Although described as being "very abundant" on this site from 1978 to 1980, only a single specimen was found in the spring of 1988 (Scarabaeus Associates 1989). Based on surveys in April 1993, the population was estimated to contain about 150 to 200 individuals; weevils were again observed at the site in April 1994 (E.L. Sleeper pers. comm.).

Recent surveys by the Endangered Species Recovery Program have confirmed that the species still occurs on this relict dune. However, only three individuals were found (Uptain et al. 1998). The three individuals were found on the top of the dune rather than on the slip face.

Life History and Habitat.—As with other species of *Trigonoscuta*, little is known about the biology or habits of individuals of the Doyen's dune weevil. They are restricted to sand soils. Weevils in this genus are associated with a wide variety of plant types, the larvae feeding on the roots and adults on the leaves (Pierce 1975, Scarabaeus Associates 1989). *Atriplex* (Scarabaeus Associates 1989) and *Astragalus oxyphysus* (Uptain et al. 1998) are known host plants. Doyen's dune weevils are flightless and nocturnal.

With large numbers having been collected from January through December, coastal species of *Trigonoscuta* seem to be active year round. Desert species, on the other hand, mostly have been taken from

March through May, with a few having been collected in January and February, indicating a shorter active season (Pierce 1975). Females have been observed laying eggs in April; first instar larvae also have been found in April (Pierce 1975). Development time and number of larval stages is not known.

Reasons for Decline and Threats to Survival.—As noted by Pierce (1975) many of the relict dunes inhabited by *Trigonoscuta* are very small in extent, but they have persisted for long periods. Surveys since the early 1960s have not located additional populations of *Trigonoscuta* on the open sandy areas of remnant dunes in the Panoche-Coalinga area of the central interior coast ranges. Although it is possible that others still could be found, the Los Medanos population is the only known extant population of *Trigonoscuta* in the San Joaquin Valley.

The primary threats to this species are the random effects of environmental and population processes facing such a small, single population; fire; off-road vehicle use; and road widening, sand stabilization, or other highway maintenance activities by the California Department of Transportation (Caltrans). The site has been burned several times by wildfire between 1994 and 1998 resulting in the complete elimination of *Atriplex*, the dune weevils' primary host plant. This has undoubtedly contributed greatly to their decline. Between 1978 and spring 1988, the area sustained "great off-road vehicle damage", vegetation had become "limited to a narrow strip along the fence line" and "were it not for the fence line, the species may well have been eliminated" (Scarabaeus Associates 1989). Dr. Sleeper (pers. comm.) has suggested that the population is relatively safe from disturbance by off-road vehicle use because of the steepness of the slip face. In recent years, off-road vehicle use at the site has been nearly eliminated. The lack of disturbance may have contributed to stabilization of the sand dune by allowing grasses and forbs to colonize the site, possibly resulting in a decline of dune weevils.

Conservation Efforts of the Three Dune Species.—The Ciervo aegialian scarab beetle, San Joaquin dune beetle, and Doyen's dune weevil are not candidates for Federal listing, but are considered species of concern (USFWS 1996). USFWS proposed that the San Joaquin dune beetle be listed as threatened in 1978, and that the four remaining (of five original) sites where it was known to exist, including the Monocline Ridge and Los Medanos sites, be designated as critical habitat (USFWS 1978). This action also would have resulted in some protection for the scarab beetle and Doyen's dune weevil populations. However, the proposal was withdrawn in 1980 (USFWS 1980*b*). In 1995, the Doyen's dune weevil was removed as a Category 1 candidate because of concerns about the taxonomy of the species (USFWS 1995*b*). There have been no formal conservation efforts for the Ciervo and Doyen's dune weevil. However, there may have been some secondary conservation effect from actions taken to protect the San Joaquin dune beetle, which was found to be "common" at the Los Medanos site in the spring of 1988 (Scarabaeus Associates 1989, p. 7).

The other three areas where San Joaquin dune beetles have been found, and two sites for the Ciervo aegialian scarab beetle are now covered under the Bureau of Land Management's *Management Plan for the Panoche/Coalinga Area of Critical Environmental Concern* (USBLM 1987). Although one of the stated objectives of this management plan is to monitor for the presence of Doyen's dune weevils, the only known population at Los Medanos, though close, lies outside the management area. Based on prior surveys, there currently is no reason to believe that the species is found in the management area.

Caltrans modified their activities so as to not disturb San Joaquin dune beetles at a site in the Los Medanos area that is within their right-of-way and across the highway from the Doyen's dune weevil population. Similarly, Caltrans will institute protection and enhancement measures for the Doyen's dune weevil (D. York pers. comm.).

Conservation Strategy for the Dune Insect Community.—Protecting the land surrounding the population of Doyen's dune weevil, and the populations of the two dune beetles on USBLM lands are important. The dune weevil's existing habitat may have to be protected from all disturbances until populations can be established elsewhere and its specific habitat requirements and life history are better known. The other two dune beetles probably do not require specific habitat management; however, because they both may feed on dung, exclusion of livestock from inhabited sites should not be considered. Protecting habitat for Doyen's dune weevil also will require clearly identifying, for the responsible parties, the location of the population. Properly publishing the species name and description of the Doyen's dune weevil is needed to clarify its status and for it to be eligible for consideration for candidate status. Translocation to suitable sites, most likely in USBLM's Panoche/Coalinga management area, is probably necessary for long-term survival of the species. Because little is known about its biology or life history, focused studies to answer questions relevant to management are important.

Conservation Actions.—For the Ciervo aegialian scarab beetle and the San Joaquin dune beetle, the major actions required to ensure conservation of these species are to learn more about their life histories and specific habitat requirements. Inhabited sites on public lands should be protected from sand mining and off-road vehicle travel. Specific habitat management actions should be based on information obtained from these ecological studies. The status of the Ciervo aegialian scarab beetle and San Joaquin dune beetle should be reevaluated within 5 years of recovery plan approval or when new information is available, whichever is less.

The situation appears most critical for Doyen's dune weevil, and the following are the requirements for ensuring conservation of this species:

1. Publish the scientific name and description of the species.
2. Immediately begin studies to:
   a. Gather information about its biology and natural history needed for management of the species.
   b. Determine the degree of threat to the species by off-road vehicle use of this site, if any, and what options exist for mitigating or eliminating such threats.
   c. Determine the degree of threat by Caltrans activities at this site, if any, and what options exist for mitigating or eliminating such threats.
   d. Determine if the introduction of the Doyen's dune weevil to new areas of suitable habitat is a feasible, practical, and acceptable option for lessening the stochastic threats to its existence.
3. Prompt implementation of whatever actions are indicated by these studies.
4. Reevaluate the status of Doyen's dune weevil within 3 years of recovery plan approval.

2. San Joaquin Antelope Squirrel
(*Ammospermophilus nelsoni*)

Taxonomy.—The San Joaquin antelope squirrel is one of five species of antelope squirrels. Members of the genus *Ammospermophilus* are confined to desert, arid steppe, and open shrubland communities in the southwestern United States and northern Mexico. *Ammospermophilus nelsoni* was described by Merriam (1893) as a member of the genus *Spermophilus*; the type specimen was from Tipton, Tulare County, California. *A. nelsoni* also has been placed in the genus *Citellus*. Taylor (1916) distinguished the northern populations as a subspecies, *A. nelsoni amplus*, but *A. nelsoni* currently is considered to be monotypic (Hall 1981, Hafner 1981).

Description.—The San Joaquin antelope squirrel (Figure 56) has a typical ground-squirrel shape: tiny, rounded ears, and streamlined, *fusiform* (spindle-shaped) body with relatively short legs and tail. The tail has laterally projecting thick fringes of hairs, and is usually held cocked or curled over the back. The upper parts are colored buffy-tan with a light stripe along the sides. The underside of the tail is light grayish or whitish. Individuals range from about 218 to 240 millimeters (8.5 to 9.4 inches) in length (Hall 1981), and adults weigh

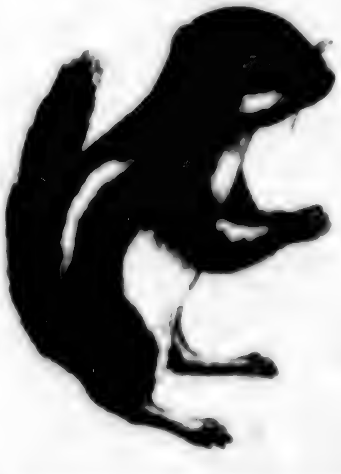

Figure 56. Illustration of a San Joaquin antelope squirrel (*Ammospermophilus nelsoni*). Drawing by Deborah Basey (© by D.F. Williams).

from about 130 to 170 grams (4.6 to 6.0 ounces) (Williams 1980).

Identification.—The San Joaquin antelope squirrel can be distinguished from the co-occurring California ground squirrel by much smaller size; shorter, less bushy tail with a flattened shape rather than the bottle-brush shape of the California ground squirrel; and the presence of a light-colored stripe along the sides of the body. Many people think antelope squirrels are chipmunks, but antelope squirrels lack the light and dark stripes on the face and the light and dark stripes on the back, which are characteristic of western chipmunks (*Tamias* spp.).

Historical Distribution.—The historical distribution of the San Joaquin antelope squirrel included the western and southern portions of the Tulare Basin, San Joaquin Valley, and the contiguous areas to the west in the upper Cuyama Valley and on the Carrizo and Elkhorn Plains (Figure 57). They ranged from western Merced County on the northwest, southward along the western side of the San Joaquin Valley to its southern end. They were distributed over the floor of the San Joaquin Valley in Kern County and along the eastern edge of the Valley northward to near Tipton, Tulare County (Hall 1981, Williams 1980). San Joaquin antelope squirrels range in elevation from about 50 meters (165 feet) on the San Joaquin Valley floor to about 1,100 meters (3,600 feet) in the Temblor Mountains. Antelope squirrels are not common above about 800 meters (2,600 feet) on the ridges and plains west of the San Joaquin Valley proper (Williams 1980, D.F. Williams unpubl. data). The area encompassed by the distribution records prior to cultivation was approximately 1,398,600 hectares (3,456,000 acres). Grinnell and Dixon (1918) wrote that San Joaquin antelope squirrels were unevenly distributed and occurred in abundance in only a few localities; one was in the Lokern and Elk Hills region of western Kern County.

Current Distribution.—Extant, uncultivated habitat for San Joaquin antelope squirrels was estimated in 1979 to be 275,200 hectares (680,000 acres) (Williams 1980). This estimate encompassed the land occupied by towns, roads, canals, pipelines, strip mines, airports, oil wells, and other developments. None of the best habitat described by Grinnell and Dixon (1918) remained. Only about 41,300 hectares (102,000 acres) was rated as fair to good quality, supporting from 3 to 10 antelope squirrels per hectare (1 to 4 per acre). Antelope squirrels had been nearly eliminated from the floor of the Tulare basin, and existed mainly in marginal habitat in the mountainous areas bordering its western edge. Substantial populations were found only in and around Lokern and Elk Hills in western Kern County, and on the Carrizo and Elkhorn Plains in eastern San Luis Obispo County.

Since 1979, San Joaquin antelope squirrels have disappeared from many of the smaller islands of habitat on the Valley floor, including Pixley National Wildlife Refuge, Tulare County; Alkali Sink and Kerman Ecological Reserves, Fresno County; and several areas within the Allensworth Conceptual Area of Tulare and Kern Counties (Williams 1980, Harris and Stearns 1991, D.F. Williams unpubl. observ., Endangered Species Recovery Program unpubl. data).

Food and Foraging.—San Joaquin antelope squirrels are omnivorous. The amount and type of food consumed are mostly dependent upon availability. The squirrels eat green vegetation, fungi, and insects more often than seeds, even when seeds are relatively abundant (Hawbecker 1975, Harris 1993). Vegetation and seeds of filaree and red brome are the main food plants (Hawbecker 1953). Insects, principally grasshoppers, are eaten regularly when available. Seeds of shrubs such as ephedra and saltbush also are staples. Seeds and insects may be necessary in the diet as sources of protein. When seeds and grasshoppers are scarce, antelope squirrels eat harvester ants (Hawbecker 1975). During spring, especially during severe drought, San Joaquin antelope squirrels eat large quantities of ovaries and developing seeds of ephedra (D.F. Williams unpubl. observ.).

Reproduction and Demography.—The breeding period for San Joaquin antelope squirrels is late winter through early spring. There is only one breeding period per year, coinciding with the time of year when green vegetation is present (Hawbecker 1953, 1958). Young squirrels do not breed their first year (Hawbecker 1975). Testes of males begin to enlarge in September or October and reach maximum size by November or December, long before the ovaries of females begin to develop (Best et al. 1990). Copulation and conception usually take place in February or March. By the end of March, testes begin to regress in size and maintain a minimum size of about 4 to 8 millimeters (0.2 to 0.3 inch) through the summer. All males are not reproductively active at the same time; some males may have enlarged testes in May (Hawbecker 1975).

Gestation lasts about 26 days. Embryos are present in

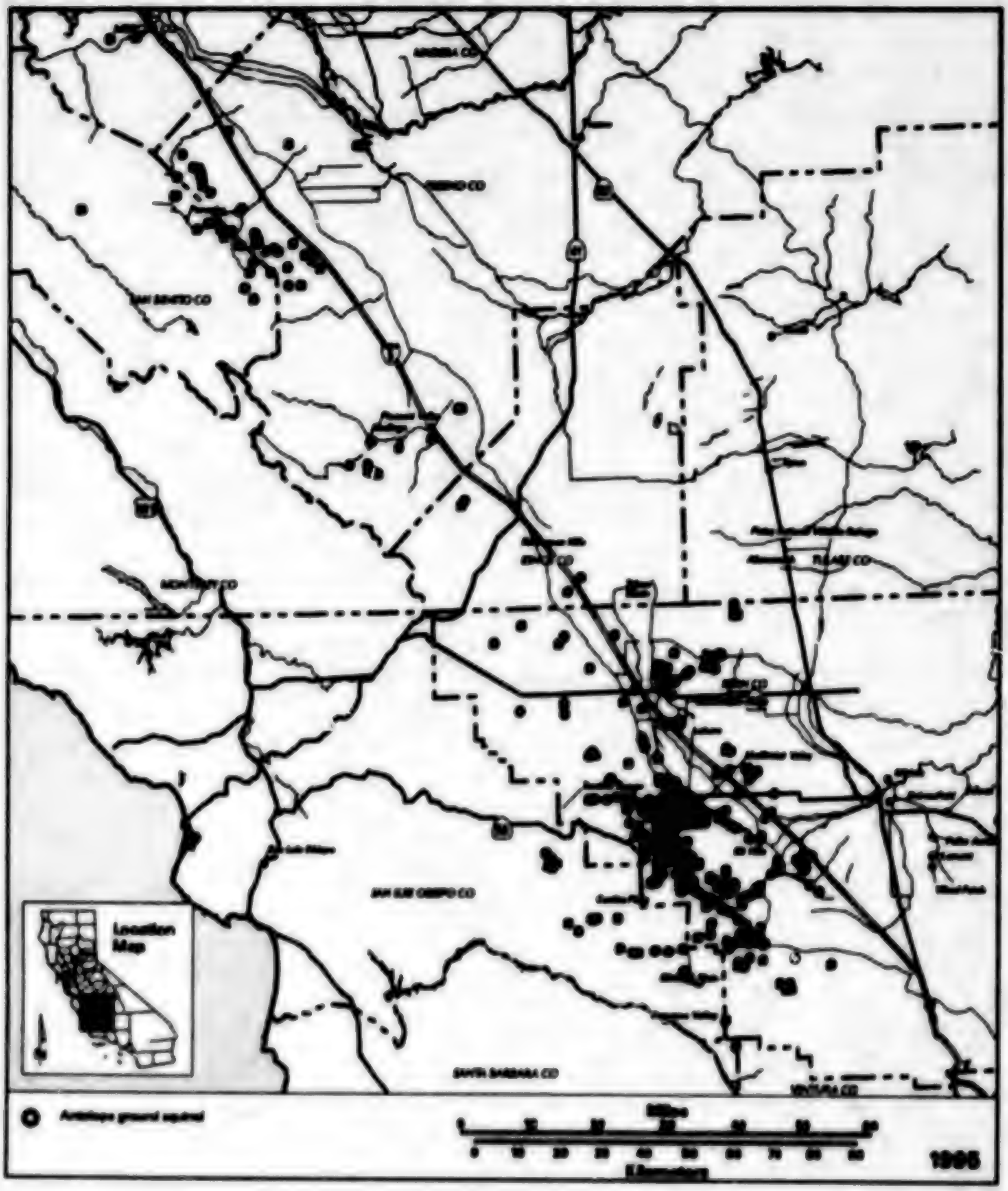

Figure 57. Distributional records for the San Joaquin antelope squirrel (*Ammospermophilus nelsoni*).

late January, but development is concentrated in February and early March. Embryos range in number from 6 to 11, with an average of 8.9 (Hawbecker 1975).

Young are born between March and April and are first seen above ground when about 30 days of age (Williams and Tordoff 1988). Young are weaned beginning in late April; the last young are weaned in mid- or late-May (Hawbecker 1975).

Timing, nature, and distance of dispersal are poorly documented; Hawbecker (1975) noted that weaned young were still together in late May. Williams and Tordoff (1988) noted at least some family groups were still together in mid-July. Young San Joaquin antelope squirrels on the Elkhorn Plain Ecological Reserve had a mortality rate of about 70 percent during their first year of life, and adults had a mortality rate from about 50 to 60 percent (Williams and Tordoff 1988).

Behavior and Species Interactions.—San Joaquin antelope squirrels live in burrows, either of their own construction or ones dug by kangaroo rats. They may also take over and enlarge burrows dug by Heermann's kangaroo rats (Grinnell and Dixon 1918, Hawbecker 1947, 1953, Williams 1980). Hawbecker (1947, 1953) believed that antelope squirrels were dependent upon kangaroo rats to dig burrows because the many burrows examined by him all seemed to have been dug by kangaroo rats. In contrast, Grinnell and Dixon (1918) believed that they dug their own burrows. Burrows vary in complexity and length, but generally have two to six openings and are between about 30 and 50 centimeters (12 to 20 inches) deep. Favored locations for burrows are in the side of an arroyo, the berm of an unimproved road, or under shrubs (Williams 1980).

Antelope squirrels make use of both shrubs and burrows of giant kangaroo rats as sites of refuge from predators as they move across their home ranges. They also regularly retreat to the shade of shrubs to avoid the heat of the sun and to dump excess body heat to the cooler, shaded ground. Burrows of giant kangaroo rats may serve the same purpose (Williams et al. 1988, Williams and Kilburn 1992).

California ground squirrels displace San Joaquin antelope squirrels and may even restrict the range of the antelope squirrel (Taylor 1916, Harris and Stearns 1991). Hawbecker (1953) noted that the range of the San Joaquin antelope squirrel may be determined, to some degree, by the range of co-occurring kangaroo rat species. The range of giant kangaroo rats most nearly coincides with that of the San Joaquin antelope squirrel, but their microhabitats generally differ in many areas. Populations of Heermann's kangaroo rats are common in most areas where antelope squirrels are found. San Joaquin kangaroo rats also occur in the same areas as San Joaquin antelope squirrels, but these kangaroo rats are much smaller; their small-diameter burrows would have to be enlarged considerably before antelope squirrels could use them (Williams 1980).

San Joaquin antelope squirrels probably compete with kangaroo rats for seeds, especially those of grasses and forbs, and, to a lesser extent, green herbaceous material. The extent to which kangaroo rats eat insects, an important staple for antelope squirrels, is unknown, but insects are probably only a minor part of their diets. Species of birds are probably the main competitors of antelope squirrels for insects (Williams and Tordoff 1988). San Joaquin antelope squirrels are prey for a variety of animals: hawks, falcons, eagles, snakes, kit foxes, coyotes, badgers and probably other predators (Williams and Tordoff 1988).

Activity Cycle.—San Joaquin antelope squirrels are primarily diurnal, usually active early or late in the day (Elliot 1904). Activity is reduced when ambient temperatures drop below about 10 degrees Celsius (50 degrees Fahrenheit) (Hawbecker 1958), but on sunny days they have been observed when air temperatures were around 0 degrees Celsius (32 degrees Fahrenheit) (D.F. Williams unpubl. observ.). Activity also is reduced at high ambient temperatures, but the amount and critical temperatures at which activity is curtailed are unclear. On the Elkhorn Plain Ecological Reserve, antelope squirrels were observed at all hours of the day and at ambient temperatures in excess of 42 degrees Celsius (108 degrees Fahrenheit) during July and August (Williams and Tordoff 1988). In contrast, Hawbecker (1958) noted that squirrels occasionally ventured into the hot sun only for short periods. They are active above ground for extensive periods during the day in the spring when temperatures are generally between about 20 to 30 degrees Celsius (68 to 86 degrees Fahrenheit).

Habitat and Community Associations.—San Joaquin antelope squirrels live in relatively arid annual grassland and shrubland communities in areas receiving less than about 23 centimeters (10 inches) of mean annual precipitation. They are most numerous in areas with a sparse-to-moderate cover of shrubs such as saltbushes, California ephedra, bladderpod, goldenbushes, matchweed, and others. Shrubless areas are only sparsely inhabited, especially where giant kangaroo rats are not present or not common.

Hawbecker (1953) believed that most antelope squirrels found in shrubless areas were nonbreeders. Yet, on the Carrizo Plain Natural Area antelope squirrels are widespread; permanent populations are found over thousands of acres without shrubs (Harris and Stearns 1991, D.F. Williams, unpubl. observ.). Grinnell and Dixon (1918) and Hawbecker (1953) observed that San Joaquin antelope squirrels rarely occurred on the Valley floor in areas with alkaline soils supporting halophytes such as iodine bush and spiny saltbush. Highly alkaline soils on the Valley floor typically have water tables within a few centimeters to a meter (1 to 40 inches) or so from the surface, perhaps limiting habitation. Steep slopes and broken, rocky, upland terrain are also scarcely inhabited (Williams 1980).

San Joaquin antelope squirrels require areas free from flooding where they can place ground burrows. Soils must be friable. Substantial colonies investigated by Hawbecker (1953) were almost always confined to loam and sandy-loam soils with moderate amounts of soluble salts, but soils with a wide range of textures are used (Williams 1980). In shrubless areas, and many areas with sparse shrub cover, San Joaquin antelope squirrels are associated with giant kangaroo rats, and they also live in burrow systems made by giant kangaroo rats (Williams and Tordoff 1988, Williams et al. 1993*b*, D.F. Williams unpubl. observ.).

In the southern and western San Joaquin Valley, San Joaquin antelope squirrels are associated with open, gently sloping land with shrubs. Typical vegetation includes saltbushes and ephedra (Hawbecker 1975). Near Panoche, San Benito County, at an elevation of about 360 meters (1,200 feet), they are associated with such plants as California ephedra, California juniper, matchweed, one-sided bluegrass (*Poa secunda* ssp. *secunda*), red brome, and red-stemmed filaree (Hawbecker 1958). Near Los Banos, Merced County, and near Mendota, Fresno County, the habitat is mostly devoid of brushy cover (Hawbecker 1947).

Reasons for Decline.—Loss of habitat to agricultural developments, urbanization, and petroleum extraction is the principal factor threatening San Joaquin antelope squirrels. Use of rodenticides for control of ground squirrels and San Joaquin antelope squirrels was reported by Grinnell and Dixon in 1918. Use of insecticides to control leafhoppers and other insects might impact antelope squirrels negatively by temporarily reducing the abundance of insects, an important source of food and moisture during summer.

Threats to Survival.—The processes of habitat loss and fragmentation are expected to continue on a much smaller scale than in the past, but the direct and indirect effects of these processes are expected to accelerate the decline of the species. Though one of the two largest and most important habitat areas, the Carrizo Plain Natural Area, is now mostly in public ownership, potential protection is tenuous for the species in the equally important population of the Lokern-Elk Hills area of western Kern County. The sale of Naval Petroleum Reserve #1 in Elk Hills to private interests (Henry 1995*a*, 1995*b*) could represent a threat to the San Joaquin antelope squirrel if rates of exploration and production are increased.

Another threat to San Joaquin antelope squirrels on private land may be the long-term effects of excessive grazing by livestock. Elimination of shrubs and soil erosion resulting from heavy use of rangeland communities by livestock can degrade their carrying capacities for most member species. First affected are those species dependent upon the plants most palatable and vulnerable to grazing and browsing by livestock. San Joaquin antelope squirrels appear to maintain good population densities on moderate-to-severely degraded rangelands where shrubs such as ephedra are common, but it is doubtful that they could maintain viability indefinitely unless the processes of overgrazing and resulting soil erosion were halted. Substantial soil erosion has occurred on both public and private lands throughout the historical geographic range of the species (Williams et al. 1993*b*, D.F. Williams unpubl. observ.). Rangeland conditions in the region have deteriorated over the last several decades, and deep gully erosion is accelerating, even in areas where livestock grazing has been curtailed or reduced.

Conservation Efforts.—The San Joaquin antelope squirrel was designated a threatened species by the State of California in 1980 (CDFG 1980). The San Joaquin antelope squirrel was removed as a Category 1 candidate for Federal listing in 1995 (USFWS 1995*b*), and is now considered a species of concern (USFWS 1996).

San Joaquin antelope squirrels were the target species for the first unit of the Allensworth Ecological Reserve (J. Gustafson pers. comm.), and one of several species benefiting from other mitigation and nonmitigation land protection actions (Table 2). The CDFG's Bird and Mammal Conservation program funded studies on ecology and habitat management of San Joaquin antelope squirrels (Williams et al. 1988) and studies of population survey methods, demography, and distribution (Harris and Stearns 1991). The Biological Resources Division of U.S. Geological Survey is studying effects of roads on San Joaquin antelope squirrels in the Carrizo Plain Natural Area, and interactions between San Joaquin antelope squirrels and giant kangaroo rats (G. Rathbun pers. comm.). The Biological Resources Division also funded a study of food habitats of San Joaquin antelope squirrels (Harris 1993).

Conservation Strategy.—San Joaquin antelope squirrels in the two largest populations on the Carrizo Natural Area and in western Kern County should be protected by appropriate land uses and habitat management. Ensuring that habitat for San Joaquin antelope squirrels is dedicated to conservation objectives will require purchase of title or easement to some parcels, and protection of habitat on existing public lands in western Kern County. Additional populations need protection, especially in western Fresno and eastern San Benito County, along the fringe of the Valley between Fresno and Kern Counties, and on the Valley floor.

The status of antelope squirrels in the Kettleman Hills and on the remaining islands of habitat in the southern San Joaquin Valley is precarious. Protection and enhancement of habitat in the Semitropic Ridge area of Kern County is important to maintaining a population on the Valley floor. Protecting and restoring habitat in the area including Pixley National Wildlife Refuge and Allensworth Natural Area (this area encompasses all the natural and abandoned farm lands in the Allensworth-Delano area of Tulare and Kern Counties), and reintroducing antelope squirrels to Pixley National Wildlife Refuge is necessary to secure a population in the eastern portions of the Valley. Both habitat restoration and management for San Joaquin antelope squirrels will require additional information derived from scientific investigations.

Conservation Actions.—Actions required to conserve the San Joaquin antelope squirrel, in approximate order of importance, are:

1. Determine habitat management prescriptions for San Joaquin antelope squirrels on the southern San Joaquin Valley floor.

2. Inventory potential habitat for San Joaquin antelope squirrels in the Allensworth, Semitropic Ridge, and Kettleman Hills natural areas, and along the western edge of the Valley between Pleasant Valley, Fresno County, and McKittrick Valley-Lokern Area, Kern County.

3. Protect additional habitat for San Joaquin antelope squirrels in the Pixley National Wildlife Refuge- Allensworth Natural Area.

4. Develop and implement a population monitoring program for San Joaquin antelope squirrels at sites representative of their existing geographic range.

5. Protect additional habitat for San Joaquin antelope squirrels in the Panoche Region of western Fresno and eastern San Benito Counties.

6. Protect additional habitat for San Joaquin antelope squirrels in western Kern County.

7. Protect additional habitat for San Joaquin antelope squirrels in the Semitropic Ridge Natural Area.

8. Reevaluate the status of San Joaquin antelope squirrels within 3 years of recovery plan approval.

3. Short-Nosed Kangaroo Rat
(Dipodomys nitratoides brevinasus)

Taxonomy.—The short-nosed kangaroo rat is one of three subspecies of the San Joaquin kangaroo rat. The type specimen of *D. n. brevinasus* was collected in 1918 from Hays Station on the upper alluvial fan of Panoche Creek, Fresno County, California (Grinnell 1920). Hafner (1979), using discriminant analysis, reaffirmed conclusions of earlier researchers that populations of *D. nitratoides* on the Carrizo Plain and west of the Kern River alluvial fan, at the northwestern edge of Buena Vista Lake, and west of the channels, sloughs, and lakes fed by the Kern River were short-nosed kangaroo rats.

Also, these waters at the west edge of the Valley floor marked the boundary between the subspecies *brevinasus* and *nitratoides*. The California Aqueduct closely follows this boundary from the Buena Vista Lake bed west of Lost Hills.

Description.—See account of the Fresno kangaroo rat for a general description of the species. Adult short-nosed kangaroo rats average larger in size than Tipton and Fresno kangaroo rats. Mean mass is about 39 to 44 grams (1.4 to 1.6 ounces), head and body length averages about 100 to 110 millimeters (3.9 to 4.3 inches), and tail length about 115 to 130 millimeters (4.5 to 5.1 inches).

Identification.—See the Fresno kangaroo rat account for ways to distinguish short-nosed kangaroo rats from other co-occurring species. The short-nosed kangaroo rat can be distinguished from the Fresno kangaroo rat by its larger average measurements: mean total length for males in different populations, 238 to 252 millimeters (9.4 to 9.9 inches); for females, 232 to 246 millimeters (9.1 to 9.7 inches); mean length of hind foot for males, 35.7 millimeters (1.41 inches); for females, 34.5 millimeters (1.36 inches); mean inflation of the auditory bullae for males, 22.6 millimeters (0.89 inch); for females, 22.4 millimeters (0.88 inch) (Hoffmann 1975) (see accounts of Fresno and Tipton subspecies for corresponding average measurements).

Historical Distribution.—The historical geographic range of short-nosed kangaroo rats is only partly known from museum and literature records and recent studies at a few sites. There has not been a comprehensive study to define historical distribution, but the inhabited area was greater than 1,000,000 hectares (2,471,044 acres). Short-nosed kangaroo rats occupied arid grassland and shrubland associations along the western half of the Valley floor and hills on the western edge of the Valley from about Los Banos, Merced County, south to the foothills of the Tehachapi Range and extending east and northward inland above the edge of the Valley floor to about Poso Creek, north of Bakersfield (Figure 58). They also occurred on the Carrizo Plain and the upper Cuyama Valley (Grinnell 1920, 1922, Boolootian 1954, Hoffmann 1974, Hall 1981, Williams and Kilburn 1992, Williams et al. 1993*b*, Hafner 1979, Williams 1985).

Current Distribution.—Current occurrences are incompletely known because there has not been a comprehensive survey for the species. Yet relatively intensive trapping surveys at several historically occupied sites with extant natural communities show that populations mostly are small, fragmented, and widely scattered. Recent large-scale survey and trapping efforts include: the Panoche Region of Fresno and San Benito Counties (D.F. Williams unpubl. data, Endangered Species Recovery Program unpubl. data); Cantua Creek, Fresno County (Williams et al. 1995, Williams and Tordoff 1988); the Kettleman Hills, Kings County (Williams et al. 1988); western Kern County (Anderson et al. 1991, EG&G Energy Measurements 1995*a,b*); Carrizo Plain Natural Area (Vanderbilt and White 1992, Williams et al. 1993*b*, Endangered Species Recovery Program unpubl. data); and Cuyama Valley (Endangered Species Recovery Program unpubl. data). Populations are known from around the edge of Pleasant Valley (Coalinga area), Fresno County; a few, scattered spots in the Kettleman and Lost Hills, Kings and Kern Counties; the Lokern, Elk Hills, San Emigdio, and Wheeler Ridge regions of western Kern County; the Carrizo Plain Natural Area; and the Caliente Mountains at the north edge of the Cuyama Valley.

Occupied habitats for areas known to support short-nosed kangaroo rats have not been completely mapped, and there are relatively large areas that offer potential habitat for the species that have not been surveyed. However, because only a few thousand acres of historical habitat on the Valley floor remain undeveloped, and this species occupies many of the same general areas occupied by giant kangaroo rats, but with a different pattern of habitat use, the extant occupied area is unlikely to be more than about 12,000 to 15,000 hectares (30,000 to 37,000 acres)—it is probably considerably less. The larger estimate represents about 1.5 percent of the estimated historical habitat. Even if there was twice this amount of currently occupied habitat and only 80 percent as much historical habitat, the currently occupied area only would be about 3.75 percent of historical habitat.

Food and Foraging.—Short-nosed kangaroo rats have essentially the same diet and foraging behavior as the other subspecies of the San Joaquin kangaroo rat (Eisenberg 1963).

Reproduction and Demography.—Captive-bred short-nosed kangaroo rats had a gestation period of 32 days and an average litter size of 2.3 (mode = 2). Litter mass at birth averaged 7.6 grams (0.27 ounce). Females showed a *postpartum* (soon after giving birth) *estrus* (Eisenberg and Isaac 1963). In captivity, a young female conceived at 12 weeks of age and produced two young

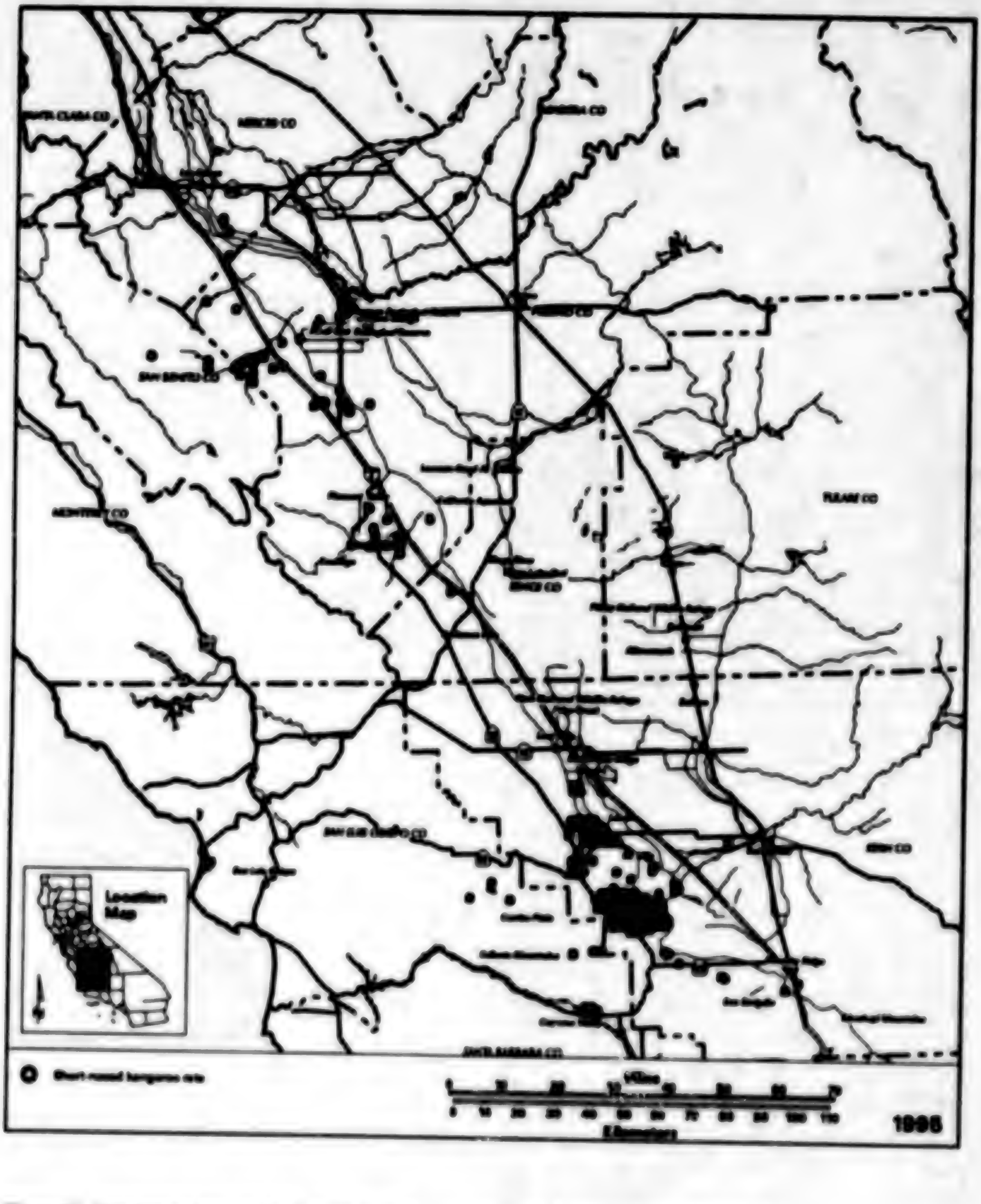

Figure 58. Distributional records for the short-nosed kangaroo rat (*Dipodomys nitratoides brevinasus*).

(Eisenberg and Issac 1963).

The reproductive season at higher elevations, such as on the Carrizo Plain Natural Area, is about 2 to 3 months shorter than on the Valley floor (see Tipton kangaroo rat account), with estrus commencing in late February or March and ending by May most years, though reproduction may continue through August in years with a prolonged wet spring. Most females appear to have only a single litter, and young-of-the-year females appear to have reproduced only when there is a prolonged wet season (Williams et al. 1993*b*, Williams and Nelson in press, Endangered Species Recovery Program unpubl. data). Like other subspecies of the San Joaquin kangaroo rat, populations of the short-nosed kangaroo rat undergo dramatic population fluctuations, and sometimes disappear from an area (Williams et al. 1993*b*, Endangered Species Recovery Program unpubl. data). On the Elkhorn Plain, the population has fluctuated, primarily in response to varying rainfall and plant productivity (Figure 59).

Behavior and Species Interactions.—Behavior of short-nosed kangaroo rats was studied extensively in the laboratory and compared to other members of the family Heteromyidae (Eisenberg 1963). Individuals usually live solitarily except when females are in estrus and tolerate the presence of a male.

Species interactions are essentially the same as for the Fresno and Tipton subspecies. Short-nosed kangaroo rats can coexist with giant kangaroo rats only where there are scattered shrubs, and on the periphery of giant kangaroo rat colonies on relatively steep, rocky slopes (Williams and Tordoff 1988).

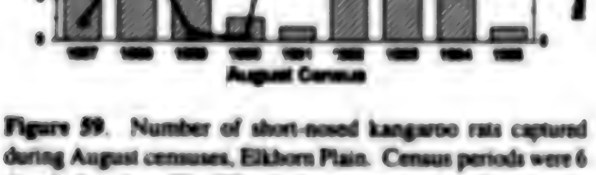

Figure 59. Number of short-nosed kangaroo rats captured during August censuses, Elkhorn Plain. Census periods were 6 days in duration. The Y2 axis shows mean net productivity per square meter (Williams et al. 1993a, Endangered Species Recovery Program unpubl. data).

Activity Cycles.—Short-nosed kangaroo rats are nocturnal and active year round. They do not become dormant. They frequently appear above ground shortly after sunset and before dark (Tappe 1941, D. F. Williams unpubl. data). They were not captured in the morning hours after sunrise on the Elkhorn Plain, but were taken in the evening before sunset (Williams and Tordoff 1988). In captivity, short-nosed kangaroo rats showed no difference in activity under simulated full-moon and new-moon conditions (Lockart and Owings 1974).

Habitat and Community Associations.—Short-nosed kangaroo rats historically were found mostly on flat and gently sloping terrain and on hilltops in desert-shrub associations, primarily saltbushes and California ephedra. On the western slopes of the Temblor Range, San Luis Obispo County, they also occur sparingly on steep, rocky hillsides among chaparral yucca, ephedra, and other shrubs, up to about 840 meters (2,750 feet) (Vanderbilt and White 1992, Williams and Tordoff 1988, D.F. Williams unpubl. data). On the Elk Hills Naval Petroleum Reserves in California, they are most abundant on flatter terrain with shrub densities between about 0.1 and 0.17 per square meter (0.1 to 0.2 per square yard), as opposed to hilly terrain with higher shrub densities (EG&G Energy Measurements 1995*a,b*).

Short-nosed kangaroo rats generally occupy grassland with scattered shrubs and desert-shrub associations on friable soils. They inhabit highly saline soils around Soda Lake, on the Carrizo Plain, and less saline soil elsewhere. On the Valley floor, south of Los Banos, Merced County, small populations, whose taxonomic identity is uncertain (*exilis* or *brevinasus*) live on levees secure from winter flooding, then move into seasonally flooded iodine bush shrublands during the summer months, where at least some individuals reproduce (Johnson and Clifton 1992). In the Panoche Valley, San Benito County, short-nosed kangaroo rats are found on gentle slopes and rolling, low hilltops where some shrubs are present (Hawbecker 1951). Over most of their current range they are generally more numerous in lighter, friable soils such as the sandy bottoms and banks of arroyos and other sandy areas (Williams and Tordoff 1988, D.F. Williams unpubl. data).

Reasons for Decline.—The main cause for decline of short-nosed kangaroo rats was the extensive agricultural developments of the 1960s through 1970s within their range, made possible by the Central Valley and State Water projects. Loss of the best habitats and the largest populations they supported, together with fragmentation and isolation, and subsequent random catastrophic events (e.g., drought, flooding, fire), have apparently caused their elimination from some sites still undeveloped. In limited areas, widespread broadcasting of rodenticides to control California ground squirrels (and sometimes kangaroo rats) may have contributed to elimination of some populations (Williams and Kilburn 1992).

Threats to Survival.—Current and potential threats cannot be adequately assessed without a more complete understanding of current distribution and population statuses. Yet, from what is known of the biology of the species, the greatest threats probably are random catastrophic events (e.g., drought, flooding, fire) and inappropriate habitat management. Short-nosed kangaroo rats appear to be particularly sensitive to buildup of too much plant material when grazing or other land uses that reduce plant cover and mulch accumulation are curtailed. They also may be harmed by overstocking range land, especially when it results in heavy browsing and death of shrubs. Fires that destroy saltbushes may reduce habitat quality for the species. These factors probably vary, with lack of grazing or other vegetation management being less important or unimportant in the most arid portions of its range and most important in the wettest.

The largest existing population of short-nosed kangaroo rats is in western Kern County in the Lokern and Elk Hills region. Though several thousand acres are in public ownership, relatively little of it is adequately protected by title or statute. Privatization of the Naval Petroleum Reserve #1 at Elk Hills could lead to greater surface disturbance if rates of exploration and production are increased. Unless a substantial proportion of the occupied habitat can be protected from development and the habitat managed by appropriate land uses, additional habitat fragmentation and habitat degradation could lead to extinction of this population by random catastrophic events (e.g., drought, flooding, fire).

Elsewhere, the only other sizable population is on the Carrizo Plain Natural Area. Though much of this is now in public ownership, between one-third and one-half of the land in the Natural Area has not been grazed since acquisition. Another several thousand acres had been cultivated since at least the 1930s, some longer, and 0.1 to 1.0 meter (0.3 to 3 feet) of topsoil were lost during that time (R. van de Hoek pers. comm., D.F. Williams unpubl. observ.). Cultivation ceased on most parcels between 1987 and 1989. Whether or not short-nosed kangaroo rats have recolonized any of the ground retired since is not known. Much of it may have lost too much soil to provide suitable habitat for this species.

On the Carrizo Plain Natural Area, lack of grazing in years of high plant productivity or other appropriate habitat management poses an unknown level of threat to conserving short-nosed kangaroo rats. Though inappropriate management probably would not result directly in elimination from the Natural Area, it probably would prevent the species' population from reaching a size and distribution that would adequately insulate it from the negative effects of random catastrophic events (e.g., drought, flooding, fire).

Conservation Efforts.—The short-nosed kangaroo rat has no protected status. It was removed as a Category 1 candidate for Federal listing in 1995 (USFWS 1995*b*), and is now considered a species of concern (USFWS 1996). Though little direct conservation action has been taken for this species, it has benefited from surveys and avoidance of impacts on Federal property (EG&G Energy Measurements 1995*a,b*); land purchases for the Carrizo Plain Natural Area by the State and Federal governments; and from land purchases for mitigation and nonmitigation in the Sand Ridge area (The Nature Conservancy), Lokern area (California Energy Commission, The Nature Conservancy, USBLM, CDFG), and possibly elsewhere in the Coalinga-Panoche regions of Fresno and San Benito Counties (Table 2). The short-nosed kangaroo rat also has benefited from the California Energy Commission's Ecosystem Protection Program surveys and plans for the Southern San Joaquin Valley (Anderson et al. 1991), and its Biological Resources Inventory of the Carrizo Plain Natural Area (Kakiba-Russell et al. 1991).

The Bird and Mammal Conservation Program of the CDFG, USBLM, Bureau of Reclamation, and Service collectively have supported research on population ecology and grazing impacts of kangaroo rats on the Elkhorn Plain that has provided information on the population dynamics of short-nosed kangaroo rats (Williams et al. 1993*b*, Williams and Nelson in press, Endangered Species Recovery Program unpubl. data). Other important information has been gathered by EG&G Energy Measurements (1995*a,b*) for the U.S. Department of Energy during their small mammal monitoring and habitat relationships studies on the Naval Petroleum Reserves in California, and the California Energy Commission's small mammal monitoring program in the Lokern Region (Anderson et al. 1991).

Conservation Strategy.—The short-nosed kangaroo rat will benefit from a detailed investigation of current distribution and population status, a population monitoring program, appropriate habitat management, and habitat protection, particularly in western Kern County, but probably also in the Panoche Region. Habitat management prescriptions are likely to differ on the Carrizo Plain Natural Area from those in western Kern County, and studies to determine appropriate land use and vegetation management regimes are needed in both areas, and probably elsewhere. The long-term protection of natural land in the Elk Hills Naval Petroleum Reserves in California and the Lokern Area are necessary to improve the status of the species. Determining the causes and stopping or reversing the decline in short-nosed kangaroo rat populations in western Kings and Fresno Counties and eastern San Benito County also are elements of conservation. A final component of the conservation strategy for this species is to restore and reintroduce short-nosed kangaroo rats to lands retired from irrigated agriculture because of drainage problems. Ideally one or more major blocks of retired land can be connected by continuous habitat along major intermittent stream channels to the natural land in the Panoche region.

Three main constituents of a conservation strategy for short-nosed kangaroo rats are:

1. Determining how to enhance habitat for short-nosed kangaroo rats that lessens the severity of cyclic population declines.

2. Consolidating and protecting blocks of suitable habitat for short-nosed kangaroo rats in western Kern, Kings, and Fresno Counties.

3. Restoring habitat for short-nosed kangaroo rats on farmland retired because of drainage problems.

Retired land ideally should be of several thousand acres each, minimally about 2,330 hectares (5,760 acres) with a core of at least 800 hectares (about 2,000 acres) of high quality habitat that is not subject to periodic flooding from overflowing streams or sheet flooding from torrential rain. They should provide topographic and biotic diversity. The vegetation should be actively managed by an appropriate level of livestock grazing to prevent excessive accumulation of mulch and growing plants until such time as optimum management conditions are determined by scientific research. Large, relatively square blocks will minimize edge with agricultural lands and the consequent pest problems at the agricultural interface.

Conservation Actions.—Needed to conserve short-nosed kangaroo rats, in priority of implementation, are:

1. Initiate and coordinate habitat management studies for short-nosed kangaroo rats at sites representing the range of existing habitat conditions for the species, in the Carrizo Plain Natural Area, Lokern / Elk Hills region, and western Fresno County.

2. Protect existing habitat for short-nosed kangaroo rats in the Naval Petroleum Reserves in California, Lokern area, and elsewhere in the region.

3. Design and implement a range-wide population monitoring program that measures population and environmental fluctuations at sites representative of the range of sizes and habitat conditions for the species.

4. Inventory and assess existing natural land within the historical range of the short-nosed kangaroo rat to assess population status.

5. Develop and implement research on restoration of habitat for short-nosed kangaroo rats on retired irrigated land.

6. Include habitat needs of short-nosed kangaroo rats in any plans by government to acquire and restore drainage-problem lands within its historical geographic range, particularly western Fresno County.

7. Restore habitat on retired agricultural lands as needed.

8. Reevaluate the status of the short-nosed kangaroo rat within 3 years of recovery plan approval.

4. Riparian Woodrat
(*Neotoma fuscipes riparia*)

Taxonomy.—The riparian or San Joaquin Valley woodrat, *Neotoma fuscipes riparia*, is one of 11 described subspecies of the dusky-footed woodrat (Hooper 1938). Although some taxonomic studies of the genus *Neotoma* have been completed in recent years, no genetic analyses or further systematic revisions of the species *N. fuscipes* have been published since Hooper's (1938) report.

Description.—The riparian woodrat (Figure 60) is a medium-sized (200 to 400 grams; 7.05 to 14.11 ounces) rodent with a stockier build and a tail that is well furred (Hooper 1938, Williams et al. 1992) and not scaled, compared to the coexisting, nonnative roof or "black" rats (*Rattus rattus*).

Identification.—*N. f. riparia* differs from other, adjacent subspecies of woodrats by being larger, lighter, and more grayish in color, with hind feet white instead of dusky on their upper surfaces, and a tail more distinctly bicolored (lighter below contrasting more with the darker dorsal color) (Hooper 1938).

Historical Distribution.—The type locality for the riparian woodrat is Kincaid's Ranch, about 3 kilometers (2 miles) northeast of Vernalis in Stanislaus County, California (Figure 61). Hooper's (1938, p. 223) taxonomic analysis used only seven specimens, all from the vicinity of the type locality, but he believed that "it probably ranges south, along the river bottom lands, as far as southern Merced County or northern Fresno County, since the same environmental conditions evidently prevail throughout this area." Hooper further pointed out that the range of the riparian woodrat was disjunct by 1938 because no suitable habitat remained between the type locality and the San Francisco East Bay region, where two other subspecies (*N. f. perplexa* and *N. f. annectens*) could be found. Hall and Kelson (1959) assigned a specimen from El Nido, Merced County to this subspecies on the basis of geography.

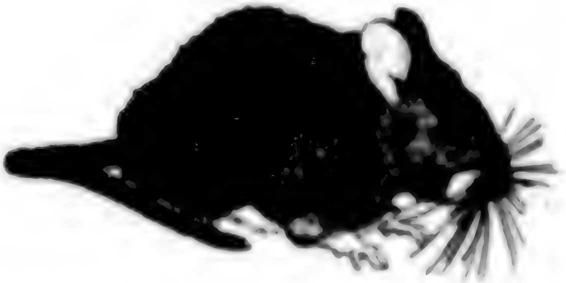

Figure 60. Illustration of a riparian woodrat. Drawing by Wendy Stevens (© CSU Stanislaus Foundation).

Current Distribution.—The range of the riparian woodrat is far more restricted today than it was in 1938 (Williams 1986). The only population that has been verified is the single, known extant population restricted to about 100 hectares (250 acres) of riparian forest on the Stanislaus River in Caswell Memorial State Park (Figure 61). Williams (1993) estimated the size of this population at 437 individuals. Analysis of California Department of Water Resources land use maps indicate that there were approximately 20 hectares (50 acres) of "natural vegetation" present along the San Joaquin River near the type locality in 1988, though no woodrats have been seen in that area. Today there is no habitat for woodrats around El Nido, which is located about 8.9 kilometers (5.5 miles) east of the San Joaquin River, the closest possible riparian habitat.

Food and Foraging.—Although some species have more specialized diets than others (e.g., Stephen's woodrat, *N. stephensi*, feeds almost exclusively on juniper), woodrats are, for the most part, generalist herbivores. They consume a wide variety of nuts and fruits, fungi, foliage and some forbs (Linsdale and Tevis 1951).

Behavior and Species Interactions.—Dusky-footed woodrats live in loosely-cooperative societies and have a *matrilineal* (mother-offspring associations; through the maternal line) social structure (Kelly 1990). Unlike males, adjacent females are usually closely related and, unlike females, males disperse away from their birth den and are highly territorial and aggressive, especially during the breeding season. Consequently, populations are typically female-biased and, because of pronounced *polygyny* (mating pattern in which a male mates with more than one female in a single breeding season), the effective population size (i.e., successful breeders) is generally much smaller than the actual population size (Kelly 1990).

Habitat and Community Associations.—Dusky-footed woodrats inhabit evergreen or live oaks and other thick-leaved trees and shrubs (Kelly 1990, Williams et al. 1992). Riparian woodrats are common, however, where

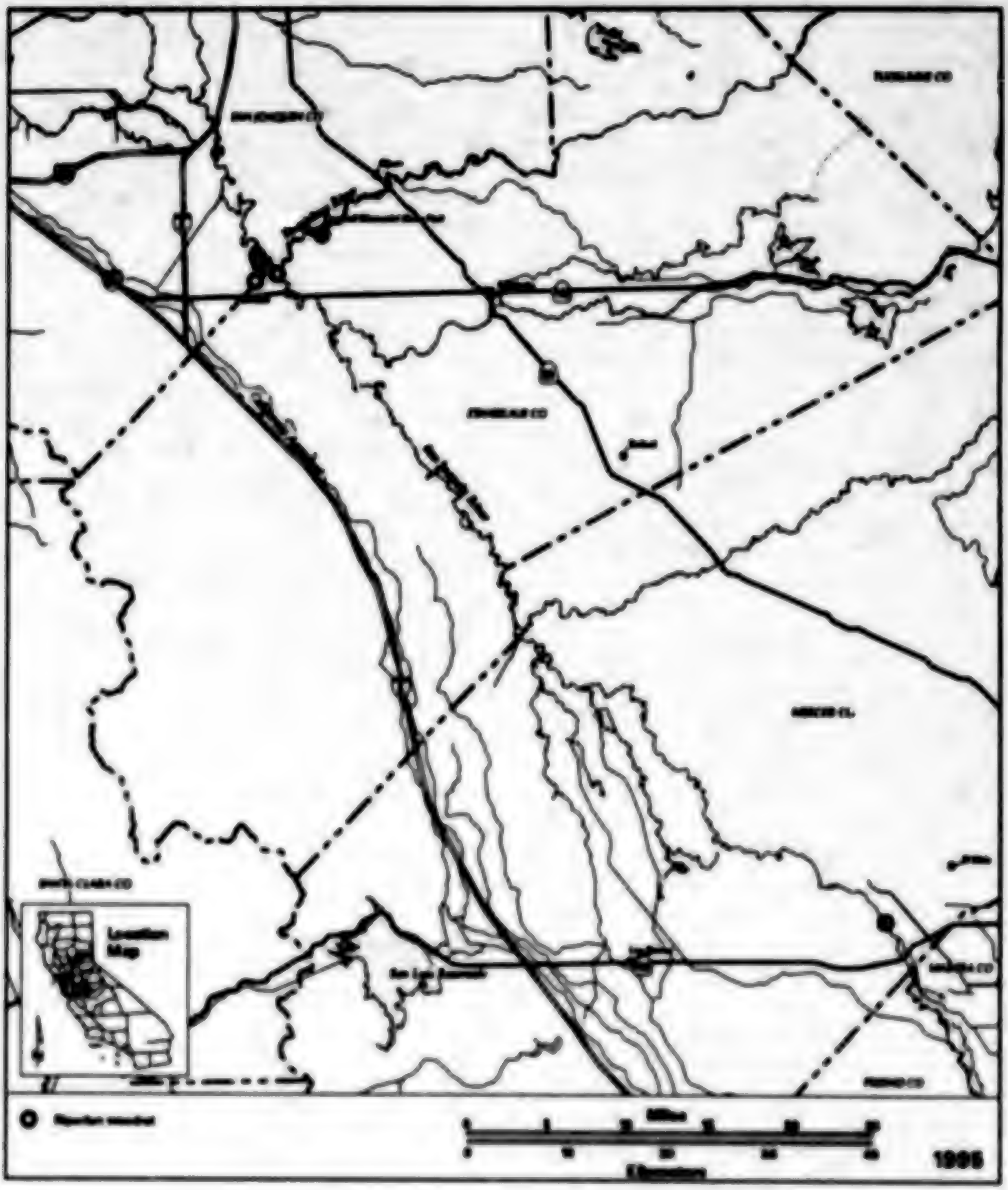

Figure 61. Distributional records for the riparian woodrat (*Neotoma fuscipes riparia*).

there are deciduous valley oaks, but few live oaks. They are most numerous where shrub cover is dense and least abundant in open areas. In riparian areas, highest densities of woodrats and their houses are often encountered in willow thickets with an oak overstory (Linsdale and Tevis 1951).

Dusky-footed woodrats are well known for their large terrestrial stick houses, some of which can last for 20 or more years after being abandoned (Linsdale and Tevis 1951, Carraway and Verts 1991). At Caswell Memorial State Park, riparian woodrats also make houses of r[illegible] and other litter (Williams 1993). At the Hastings Reserve, Monterey County, dusky-footed woodrat houses range from 60 centimeters (2 feet) to 150 centimeters (5 feet) in height, and can be 120 centimeters (4 feet) to 240 centimeters (8 feet) in basal diameter. Houses typically are placed on the ground against or straddling a log or exposed roots of a standing tree and are often located in dense brush. Nests also are placed in the crotches and cavities of trees and in hollow logs. Sometimes tree nests are constructed but this behavior seems to be more common in habitat with evergreen trees such as live oak (Williams et al. 1992).

Reasons for Decline.—Although there is still no good estimate of the amount of riparian habitat remaining in the San Joaquin Valley, it is only a vestige of what it was 50 to 100 years ago. Thus, loss and fragmentation of habitat are the principal reasons for the decline of the riparian woodrat. Much of this loss was the result of the construction of large dams and canals which diverted water for the irrigation of crops and permanently altered the hydrology of Valley streams. More was lost through cultivation of the river bottoms. Historically, cattle also probably impacted riparian woodrat populations since the thick undergrowth, which is particularly important to woodrats, is sensitive to trampling, browsing and grazing by livestock.

Threats to Survival.—The only known extant population of riparian woodrat is small, with its size limited by the available habitat. It is thus at an increased risk of extinction because of genetic, demographic, and random catastrophic events (e.g., drought, flooding, fire) that threatens small, isolated populations. Because of its breeding behavior, the effective size of woodrat populations is generally much smaller than the actual population size. This increases the risk of inbreeding depression.

The woodrat population at Caswell Memorial State Park is vulnerable to flooding of the Stanislaus River. Because of its well-developed arboreality (ability to climb in trees), the woodrat itself is not as sensitive to flooding as some other brush-dwelling species (e.g., the riparian brush rabbit). However, woodrat houses are essential for survival and these can be severely impacted by flooding, thus affecting population viability.

Conservation Efforts.—The riparian woodrat was proposed for listing by the USFWS on November 21, 1997 (USFWS 1997). Although the only known population has some protection by residing in Caswell Memorial State Park, there are currently no conservation efforts underway specifically to benefit the riparian woodrat. The California Department of Parks and Recreation, however, has supported some general small-mammal studies and studies on the woodrat population at Caswell (Cook 1992, Williams 1993).

Conservation Strategy.—Unlike many other sensitive species in the San Joaquin Valley, the life history of the riparian woodrat is particularly well known through studies on other subspecies of the dusky-footed woodrat, particularly *N. f. luciana* (Linsdale and Tevis 1951, Kelly 1990). However, using this information to develop a conservation plan is hampered by a lack of data on the current status and distribution of the species. Thus, surveys along all river corridors throughout its historical range to identify and map remaining riparian habitat and extant woodrat populations, if any are found, must be a primary element of a conservation strategy for the riparian woodrat.

Any conservation strategy for the riparian woodrat should focus on a long-term goal of reducing the effects of population fragmentation by establishing, wherever possible, linkages (corridors) between remnants of riparian habitat. If additional riparian woodrat populations are discovered by surveys, priority should be given to connecting occupied habitat patches. However, if no additional populations are found, then convenient or logical fragments will have to be reconnected and reintroduction of the species will be an important component of the conservation strategy.

Because much of the river bottom land in the San Joaquin Valley is in private ownership, a concerted outreach effort must be made to enlist the help of landowners in the conservation of riparian woodrats and their habitat. Through progressive habitat conservation plans and other existing programs (e.g., Riparian Habitat Joint Venture, Partners for Wildlife Program, and the evolving "safe-harbor" concept), incentives must be provided to encourage the establishment or restoration of riparian habitat.

All these conservation activities will depend on the understanding and receptivity of private landowners. Many of the private parcels of potential habitat for riparian woodrats on the Stanislaus and lower San Joaquin Rivers have federally-owned wildlife habitat and flood easements, administered by the U.S. Army Corps of Engineers (COE). This is true of the entire riparian corridor of the Stanislaus River downstream from Caswell Memorial State Park in Stanislaus and San Joaquin Counties. The COE must diligently inspect parcels with wildlife easements and ensure that the requirements of those easements are being met. Beyond that, the development of an effective outreach and incentive program focused on the owners of riparian lands is a critical and early step of any conservation strategy.

Conservation of the riparian woodrat may be furthered by changes in the management of National Wildlife Refuges in the San Joaquin Valley that will make these refuges more hospitable to riparian species. Such changes are specifically needed to help recover the riparian brush rabbit (as discussed elsewhere in this plan) and the woodrat.

Conservation Actions.—Conserving the riparian woodrat depends on good information on status and distribution and sufficient protected habitat. To achieve these goals requires these actions:

1. A survey and mapping of all riparian areas along the San Joaquin River and its major tributaries is of the highest priority. A cost-effective survey can be carried out through a combination of aerial photo interpretation, selective truthing of photos on the ground, and judicious trapping where permission is required and given.

2. Develop in collaboration with owners of riparian land and local levee-maintenance districts an incentive program for preserving cover and riparian vegetation.

3. Develop a plan for the restoration of riparian habitat, the establishment of riparian corridors, and the reintroduction, if necessary, of riparian woodrats to suitable habitat.

4. Initiate a genetic study of the Caswell Memorial State Park woodrats, and any other riparian woodrat populations that can be sampled, to determine inbreeding levels; and devise a procedure for ensuring that translocations neither reduce genetic diversity in the parent population nor unduly restrict it in the translocated population.

5. Establish conservation agreements with willing landowners that do not already have conservation easements, as appropriate and necessary, to accomplish habitat restoration, linkage, and reintroduction goals.

6. Begin efforts to restore and link riparian habitat, and reintroduce woodrats, as appropriate.

Although the timing of these management actions may depend on the development of additional information through surveys, some combination of actions will almost certainly be necessary for conservation. Therefore to the extent possible, planning for such action should go forward along with surveys. Then appropriate management action can follow without delay when surveys are finished.

5. Tulare Grasshopper Mouse
(Onychomys torridus tularensis)

Taxonomy.—The genus *Onychomys* was described by Baird (1858). The southern grasshopper mouse was described as *Hesperomys (Onychomys) torridus* by Coues (1874). The Tulare grasshopper mouse (*O. torridus tularensis*), one of 10 currently recognized subspecies, was described by Merriam (1904*b*) from the type specimen collected near Bakersfield, Kern County, California.

Description.—In general, mice of the genus *Onychomys* have stout bodies with short, relatively thick tails (Figure 62). The pelage is sharply bicolored with the head, back, and upper sides pale-brown to grayish or pinkish cinnamon and the underparts white and distinctly different from the upper parts. The tail is usually bicolored with a white tip (Hall and Kelson 1959, McCarty 1975). Juvenile pelage is gray; adult pelage is buffy or tawny; and the pelage of older individuals may be gray, closely resembling subadults in color (Hall and Kelson 1959). Within-species variation in adult coat color may be a result of adaptation to local environmental conditions (McCarty 1975). The total body length of the southern grasshopper mouse ranges from 119 to 163 millimeters (4.69 to 6.42 inches); tail length, 33 to 62 millimeters (1.30 to 2.44 inches); hind foot length, 18 to 23 millimeters (0.71 to 0.91 inch); and ear length from notch, 11 to 18 millimeters (0.43 to 0.71 inch). Tail length is usually more than half the length of the body (48 to 56 percent) (Hall and Kelson 1959).

The southern grasshopper mouse has five *tubercles* (knob-like fleshy bumps) on the sole of each forefoot, and four on each hind foot. The soles of the feet are covered with fur from heel to the beginning of the tubercles (McCarty 1975).

Identification.—The Tulare grasshopper mouse can be told externally from coexisting species of white-footed mice (*Peromyscus* spp.) by its relatively short, club-like tail and larger forefeet (McCarty 1975).

Historical Distribution.—The Tulare grasshopper mouse historically ranged from about western Merced and eastern San Benito Counties east to Madera County and south to the Tehachapi Mountains; on the east, they ranged from Madera County south (Figure 63) (Newman and Duncan 1973, Williams and Kilburn 1992).

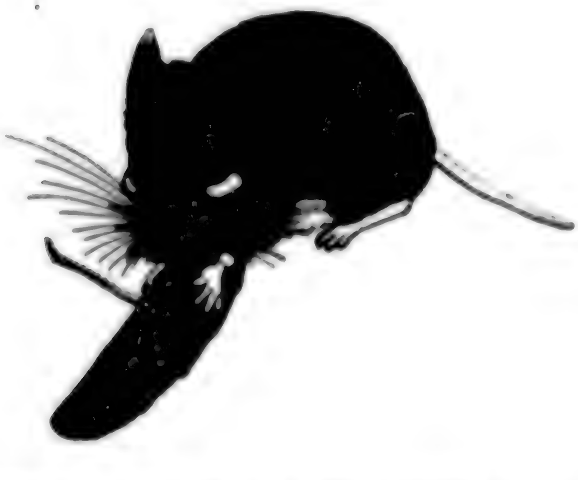

Figure 62. Illustration of a Tulare grasshopper mouse. Drawing by Wendy Stevens based on photos © by B. Moose Peterson.

Current Distribution.—Currently, Tulare grasshopper mice are known to occur along the western margin of the Tulare Basin, including western Kern County, Carrizo Plain Natural Area, along the Cuyama Valley side of the Caliente Mountains, San Luis Obispo County, and the Ciervo-Panoche Region, in Fresno and San Benito Counties (Williams and Kilburn 1992, D.F. Williams unpubl. data). Though there has not been a comprehensive survey of existing potential habitat, there are several large blocks of historical habitat on the floor of the Tulare Basin where extensive trapping has occurred, but no Tulare grasshopper mice have been captured, such as Alkali Sink Ecological Reserve, Fresno County, and Pixley National Wildlife Refuge, Tulare County (Endangered Species Recovery Program unpubl. data). The only recent record is the capture of a grasshopper mouse in 1994 at Allensworth Ecological Reserve (CDFG in litt. 1998).

Food and Foraging.— Southern grasshopper mice eat mostly small animals, with insects forming the bulk of their diets (Bailey and Sperry 1929, Chew and Chew 1970, Horner et al. 1964). Prey items include scorpions, beetles, grasshoppers, pocket mice, and western harvest mice. Other ingested animals include spiders, mites, ants, insect cocoons, caterpillars, lizards, and frogs (*Rana* sp.) (Horner et al. 1964). They also eat seeds. Captive grasshopper mice stored sunflower seeds in their nest boxes during the winter months. The cache was used only when no other food source was available (Bailey and Sperry 1929).

Reproduction and Demography.—Specific information on the reproduction and the mating system of Tulare grasshopper mice is unknown. For southern grasshopper mice in general, breeding occurs throughout the year in laboratory settings, but is seasonal in natural populations (McCarty 1975). Gestation is between 27 and 32 days, with two to six young born per litter. In the wild, Tulare grasshopper mice may produce up to three litters per year. Most litters are born from May through July, with a sharp decline in August (Taylor 1968). Both male and female southern grasshopper mice care for the young (Horner 1961).

The reproductive efficiency of female grasshopper mice declines significantly following the first year. Taylor (1968) reported that only 17 percent (8 of 47) of females that bore young in the laboratory bred in their second year, and only 2 percent (1 of 47) continued into the third year. Female southern grasshopper mice rarely

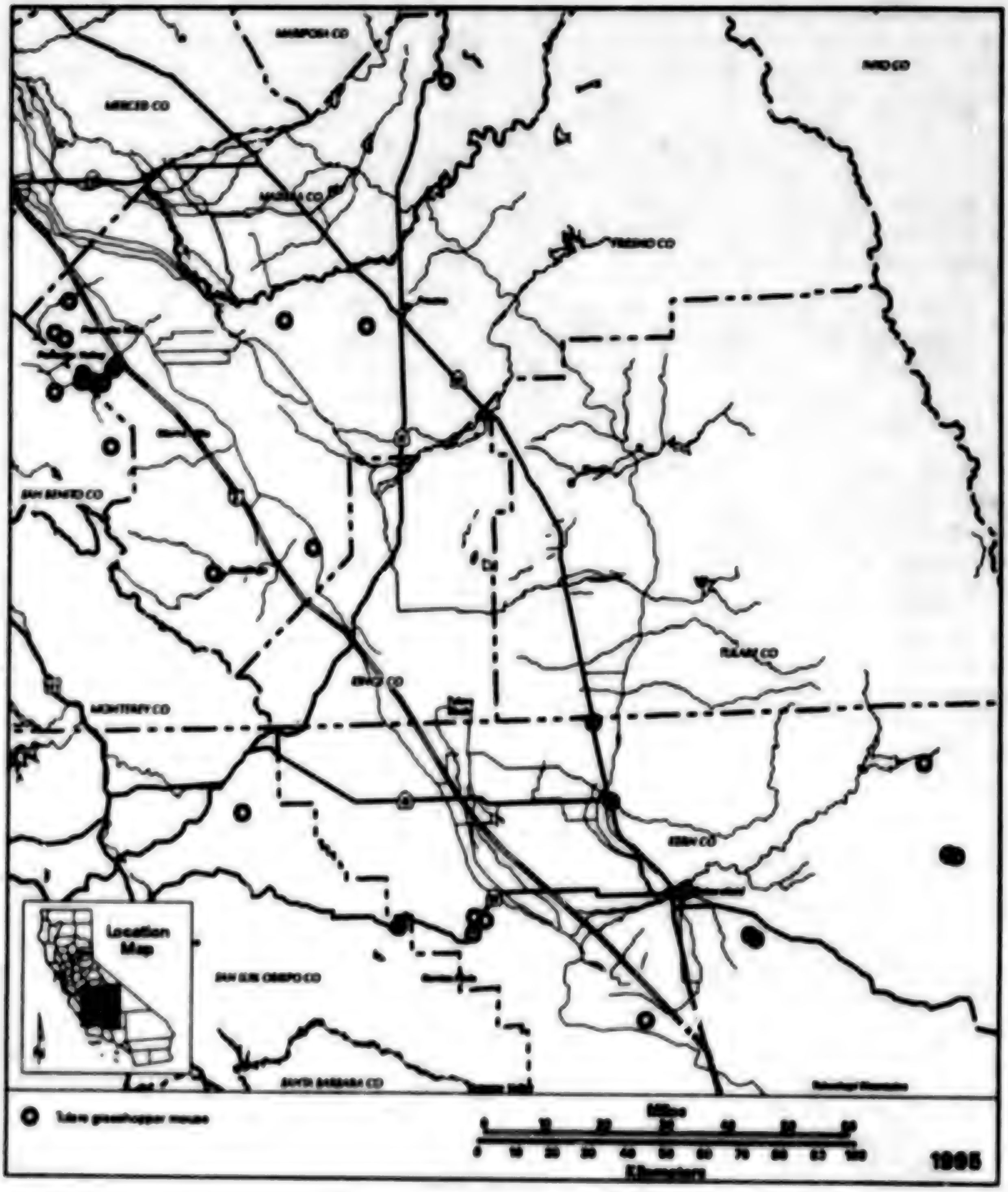

Figure 63. Distributional records for the Tulare grasshopper mouse (*Onychomys torridus tularensis*).

remain reproductively active in the laboratory after 2 years of age. The oldest female to successfully rear a litter was 24 months old. The oldest male to sire a litter was 31 months old (Pinter 1970). Southern grasshopper mice survived in the laboratory up to 3 years, but mice in the wild probably live less than 12 months (Horner and Taylor 1968).

Females appear to be sexually active for a single breeding season, with a rapid onset of reproductive senility following the first year. Females born early in the year (April) may produce two or three litters prior to the end of the breeding season. Females born later in the year would have the potential to produce up to six litters in the following breeding season, but seasonality of breeding probably reduces the actual number to one to three litters. Distinct lulls in the testicular activity of males during the breeding season also may contribute to low population densities (Taylor 1963).

There is no information on demography or dispersal of Tulare grasshopper mice. Generally, southern grasshopper mice exist at relatively low density and have home ranges much larger than similarly-sized rodents such as white-footed mice (McCarty 1975).

Behavior and Species Interactions.—The most consistent social unit is reported to be a male-female pair with offspring in a burrow system within a wide home range (McCarty 1975). Blair (1943) reported the home range size of male southern grasshopper mice was 3.2 hectares (7.8 acres), and that of females was 2.4 hectares (5.9 acres). The nest of the southern grasshopper mouse is typically located in a burrow system that may have been abandoned by another small mammal (Bailey and Sperry 1929, Hall and Kelson 1959).

Adult males are highly territorial and frequently vocalize during nocturnal activity. Adult males emit a high-pitched call, lasting several seconds, while standing on the hind legs with head raised and mouth open. Calls are less frequently given by females. Calling appears to function as a territorial and spacing mechanism (McCarty 1975).

Small mammals associated with Tulare grasshopper mice include giant kangaroo rats, San Joaquin kangaroo rats (all three subspecies), Heermann's kangaroo rats, California ground squirrels, San Joaquin antelope squirrels, San Joaquin pocket mice, California pocket mice, deer mice, harvest mice, and house mice (Hawbecker 1951, D.F. Williams unpubl. data).

Predators of the Tulare grasshopper mouse are known to include American badgers, San Joaquin kit foxes, coyotes, and barn owls (Hawbecker 1951).

Activity Cycles.— Tulare grasshopper mice are nocturnal and active year round. They probably do not become dormant, at least not for long periods, though in captivity individuals have exhibited short episodes of torpor (D.F. Williams unpubl. observ.). Other aspects of activity of Tulare grasshopper mice are unknown.

Habitat and Community Associations.—Tulare grasshopper mice typically inhabit arid shrubland communities in hot, arid grassland and shrubland associations (Williams and Kilburn 1992). There is little information about the habitat requirements of the Tulare subspecies. Habitats recorded in the literature include Blue Oak Woodland at 450 meters (1,476 feet) where it is very rare (Newman and Duncan 1973), and Upper Sonoran Subshrub Scrub (Hawbecker 1951). Other reported habitats are alkali sink, dominated by one or more saltbush species, iodine bush, seepweed, and pale-leaf goldenbush; mesquite associations on the Valley floor; saltbush scrub; Upper Sonoran shrub associations dominated by California ephedra/Anderson desert thorn; and grassland associations (primarily Arabian grass and red brome) on the sloping margins of the San Joaquin Valley and the Carrizo Plain region (Williams and Tordoff 1988).

Reasons for Decline.—The habitat reduction, fragmentation, and degradation accompanying settlement and development of the Valley for agriculture are the principal causes of decline of Tulare grasshopper mice. Random catastrophic events (e.g. floods, drought combined with their low reproductive rate and other demographic factors probably are the most significant factors in elimination of fragmented populations. However, use of insecticides (first DDT and others, now mainly malathion) on natural lands to control beet leafhoppers could have contributed to the disappearance of grasshopper mice from fragmented islands of natural land on the Valley floor, both from direct and indirect poisoning, and reduction of their staple food, insects. Rodenticides targeted for ground squirrels and insecticide drift from adjacent farmland may also have been a factor in elimination of grasshopper mice from fragmented parcels on the Valley floor.

Threats to Survival.—Habitat fragmentation and loss to cultivation, and, perhaps, inappropriate land management, are the most serious threats to Tulare grasshopper mice. The naturally low reproductive rate, low population density, and large home range characteristic of southern grasshopper mice (McCarty 1975) make this subspecies particularly vulnerable to loss and fragmentation of habitat (Williams and Kilburn 1992). There are no current overall estimates of population size for this subspecies.

Conservation Efforts.—The Tulare grasshopper mouse is not a candidate for Federal listing, but is considered a species of concern (USFWS 1996).

Conservation Strategy.—The Tulare grasshopper mouse lives in the same communities as the listed kangaroo rats, blunt-nosed leopard lizard, and San Joaquin kit fox. Its habitat needs, then, are essentially the same as those of other members of this arid grassland and shrubland community assemblage. Protecting habitat for the listed members of this assemblage should simultaneously protect habitat for Tulare grasshopper mice. Of greatest concern, however, is the apparent elimination of populations on the Valley floor. This loss, if substantiated, suggests relatively high vulnerability to extinction by random catastrophic events (e.g., drought, flooding, fire) or use of pesticides on even relatively large habitat areas. Effort needs to be directed at reaching an understanding of the environmental factors of islands where extinction has occurred. Knowledge gained can be used in refining a strategy for ensuring that the same processes do not result in further eliminations and eventual extinction of the entire metapopulation.

Conservation Actions.—Habitat protection needs for Tulare grasshopper mice are essentially the same as those for San Joaquin antelope squirrels and the three subspecies of the San Joaquin kangaroo rat. Additional measures of highest priority for conservation of the Tulare grasshopper mice are:

1. Determine the current distribution and population status of Tulare grasshopper mice on isolated blocks of historical habitat on the Valley floor of the Tulare Basin.

2. Analyze the environmental features of inhabited and uninhabited fragmented islands of natural land on the Valley floor to determine factors, including pesticide use, that might be associated with survival and elimination.

3. Establish a range-wide monitoring program at sites representative of the range of occupied communities and areas.

4. As (if) habitat areas on the Valley floor are increased in size by retirement of agricultural land, restore habitat and reintroduce Tulare grasshopper mice.

5. Include Tulare grasshopper mice in studies of management and land uses on habitat of other species of the same community associations.

6. Reevaluate the status of the Tulare grasshopper mouse within 3 years of recovery plan approval.

6. Buena Vista Lake Shrew
(Sorex ornatus relictus)

Taxonomy.—The Buena Vista Lake shrew *(Sorex ornatus relictus)* was described by Grinnell (1932*b*) from the type specimen collected near Buena Vista Lake, Kern County, California. This shrew is one of nine subspecies of the ornate shrew *(Sorex ornatus)* (Merriam 1895, Hall 1981, Junge and Hoffmann 1981).

The systematic status of the Buena Vista Lake shrew is uncertain because only a few specimens have been available for comparison and a review of the systematics of the species has not been completed (Maldonado 1992). An evaluation of the systematics of the group, using DNA analysis, is currently underway. Preliminary results indicate that the Buena Vista Lake shrew is a distinct evolutionary unit of ornate shrew (J. Maldonado pers. comm.).

Description.—Ranges of external measurements from the type specimen and two additional specimens are: total length, 98 to 105 millimeters (3.86 to 4.13 inches); tail length, 35 to 39 millimeters (1.38 to 1.54 inches); hind foot length, 11.5 to 13 millimeters (0.45 to 0.51 inch); and ear length from the notch, 6.5 to 8.5 millimeters (0.26 to 0.33 inch). Weights ranged from 4.1 to 7.6 grams (0.14 to 0.27 ounce). The upper surface of the Buena Vista Lake shrew is blackish-brown, with a pepper-and-salt pattern of buffy brown and black, the black predominating. The sides are more buffy brown than the upper surface. The lower surface is smoke gray. The tail is not noticeably bicolored and darkens towards the end, both above and below (Grinnell 1932*b*).

Identification.—The Buena Vista Lake shrew (Figure 64) differs externally from *S. ornatus ornatus*, whose range surrounds that of *S. o. relictus*. The coloration of the Buena Vista Lake shrew is distinctly darker, grayish-black, rather than brown. The body size is slightly larger, but the tail is shorter. The teeth are essentially the same, but the third and fifth unicuspids (teeth behind the incisors that have a single main cusp) are even smaller relative to the other teeth (Grinnell 1932*b*).

Historical Distribution.—The Buena Vista Lake shrew formerly occurred in wetlands around Buena Vista Lake, and presumably throughout the Tulare Basin (Grinnell 1932*b*, 1933*a*; Williams and Kilburn 1984, Williams 1986). As early as 1933, Grinnell (1933*a*) found the distribution of this species to be much restricted due to the disappearance of lakes and sloughs. Since Grinnell's (1932*b*) report, Buena Vista Lake and the surrounding lakes and Valley Freshwater Marshes have been drained and cultivated. Further, canals in the area are steep-sided and kept free of vegetation (Williams and Kilburn 1992).

Current Distribution.—Little is known about the current distribution of the Buena Vista Lake shrew. It was rediscovered in 1986 by Robert Hansen during excavations on the Kern Lake Preserve (Figure 65) (D.F. Williams unpubl. observ.). The status of this population was assessed in the early 1990s (Center for Conservation Biology 1990, Maldonado 1992) and most recently in 1995 (Maldonado 1998). Two shrews were also collected in 1992 and one in 1994 at the Kern National Wildlife Refuge (J. Allen pers. comm.). Water management practices at the Refuge have focused on waterfowl, and riparian habitat has not received adequate water over the years to maintain riparian diversity (Engler in litt. 1994). Any other extant populations found within the Tulare Basin may or may not be representative of the Buena Vista Lake shrew. No other recent records of this shrew are known, though only a few biological surveys have included attempts to capture shrews (Clark et al. 1982, Germano in litt. 1992, T. Kato pers. comm., S. Tabor pers. comm.).

Figure 64. Illustration of a Buena Vista Lake shrew. Souce: Daniel F. Williams.

Conservation Efforts.—The Buena Vista Lake shrew is a Federal candidate for listing as threatened or endangered (USFWS 1996), and is a California State Mammalian Species of Special Concern (Williams 1986).

Food and Foraging.—The specific feeding and foraging habits of the Buena Vista Lake shrew are unknown. In general, shrews primarily feed on insects and other animals, mostly invertebrates (Harris 1990, Williams 1991, Maldonado 1992). Food probably is not cached and stored, so the shrew must forage periodically day and night to maintain its high metabolic rate.

Reproduction.—Nothing is known specifically about the reproduction and mating system of the Buena Vista Lake shrew. In general, the reproductive period of the ornate shrew extends from late February through September and early October (Rudd 1955, Brown 1974, Rust 1978). The breeding season of the Buena Vista Lake shrew may begin in autumn and end with the onset of the dry season in May or June. In high-quality habitat in permanent wetlands, the breeding season may be extended (Center for Conservation Biology 1990, Williams in litt. 1989). Up to two litters are produced per year containing four to six young (Owens and Hoffman 1983).

Demography.—Little is known about population numbers, home range, or territoriality of the Buena Vista Lake shrew or ornate shrews in general. Twenty-five Buena Vista Lake shrews were captured during four trapping sessions from December 1988 through May 1989. Only one animal was recaptured (Freas 1990). In captivity, ornate shrews defend nest sites (Newman 1976). Population densities of the taxonomically related species, *S. vagrans vagrans*, in western Washington, varied from about 25.8 per hectare (10.12 per acre) in fall and winter to 50.2 per hectare (20.32 per acre) at the high point in summer (Newman 1976). Though no values are available for *S. ornatus*, trapping results suggest that *S. o. relictus* exists at much lower densities, probably no more than 10 to 15 per hectare (4 to 6 per acre) at the high point. Assuming a density of 13 per hectare (5.3 per acre), and a desired population size of no less than 5,000

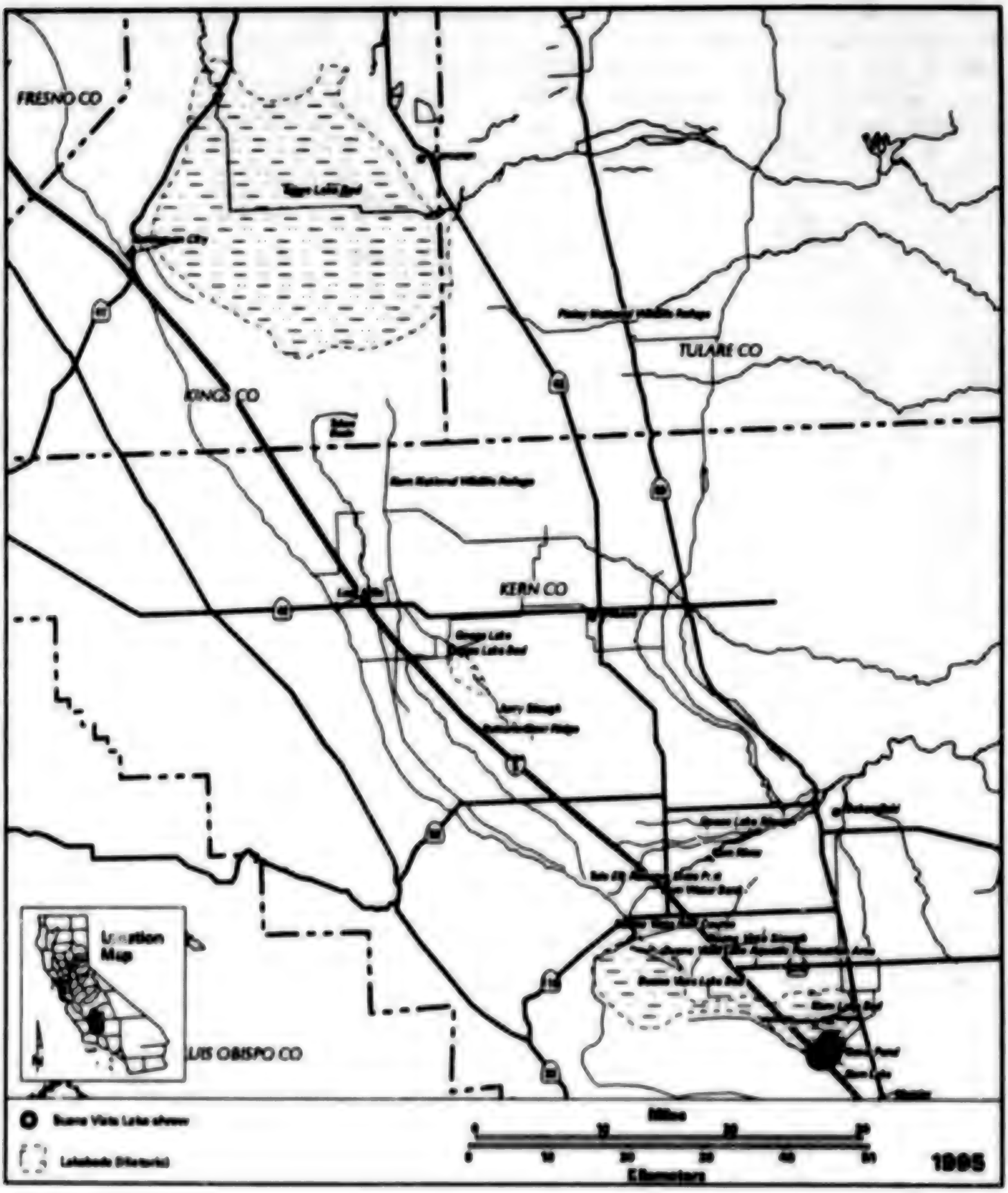

Figure 65. Recent distributional records for the Buena Vista Lake shrew *(Sorex ornatus relictus)*.

individuals, approximately 400 hectares (1,000 acres) of occupied habitat would be required for long-term conservation.

Behavior and Species Interactions.—Pairs of ornate shrews lived together in captivity without antagonism if adequate food and water were provided (Owen and Hoffmann 1983). Although shrews were not observed burrowing in leaf litter on cage floors, they are thought to burrow in natural settings (Rudd 1953). During hot weather in dry habitats, the ornate shrew may restrict its daytime activity to burrows of other animals (Pearson 1959).

Activity Cycle.—Ornate shrews are active day and night (Pearson 1959, Newman and Rudd 1978, Rust 1978). Nocturnal activity predominates, especially during the breeding season, in the Suisun shrew (*S.o. sinuosus;* Rust 1978). The intensity and distribution of activity within a 24-hour period varies with sexual maturity (Rust 1978).

Habitat and Community Associations.—Ornate shrews in general tend to be associated with the structure of the vegetation rather than with species composition of the community (Owen and Hoffmann 1983). Buena Vista Lake shrews occupied Valley Freshwater Marshes on the perimeter of Buena Vista Lake and probably occurred throughout the Tulare Basin (Williams 1986), though most of the marshlands were drained or dried up prior to the discovery of the shrew in 1932 (Grinnell 1932*b*). Recent captures on the Kern Lake Preserve occurred in areas with a dense wetland vegetative cover and an abundant layer of detritus (decomposed vegetation) (Center for Conservation Biology 1990, Maldonado 1992). Plant species associated within these areas include Fremont cottonwood *(Populus fremontii)*, willows *(Salix* spp.), glasswort, alkali heath, wild-rye grass *Elymus* sp.), and Baltic rush *(Juncus balticus)*. Animal species captured on the Preserve, but only in the xerophytic community, were deer mice and California pocket mice (Center for Conservation Biology 1990).

Reasons for Decline.—Loss and fragmentation of habitat are the major causes for decline and threat to the Buena Vista Lake shrew's survival (Williams and Kilburn 1984, 1992). The conversion of natural lands to agriculture and diversion of fresh water supplies have eliminated most of the riparian habitat that once supported the shrew, reducing the subspecies to what may be a single remaining population. By the early 1930s, the former Tulare, Buena Vista, Goose, and Kern lakes were virtually dry and open for cultivation (Griggs 1992). Historical Buena Vista Lake now is cultivated, and Kern Lake has been reduced to 13.4 hectares (33 acres) with a small pond and artificially-maintained wetland, and a more xerophytic community of annual and perennial saltbushes, saltgrass, and annual grasses and forbs (Center for Conservation Biology 1990, Williams and Kilburn 1992).

Threats to Survival.—The Buena Vista Lake shrew is a limited local endemic subspecies (Williams and Kilburn 1992), has never been found to be locally abundant, and lives in very restricted areas of marshy wetland habitat (Bradford 1992). Because the sole population is small (only 10 individuals as of 1995) and occurs in a single small location (30 acres at the former Kern Lake Preserve), the Buena Vista Lake shrew is extremely vulnerable to natural or human-made environmental impacts. Kern Lake Preserve is privately owned by the J.G. Boswell Company, and was privately managed by The Nature Conservancy until recently. The partnership between The Nature Conservancy and J.G. Boswell Company was terminated in early 1995, and efforts by USFWS to negotiate a Conservation Agreement with J.G. Boswell Company have failed (Reed Tollefsun pers. comm., K. Freas pers. comm.). Thus, the shrew's only known habitat is without protection, and there is a possibility that the water supply that maintains the pond and wetland plant community will be diverted elsewhere for irrigated agriculture. Elevated concentrations of selenium also represent a serious human-made environmental threat to the Buena Vista Lake shrew. Ornate shrews captured at Kesterson National Wildlife Refuge showed selenium concentrations three to twenty-five times greater than those found for any other small mammal at the same site (Clark 1987). High selenium levels have been measured in evaporation ponds within the agricultural lands immediately surrounding the former Kern Lake Preserve (California Department of Water Resources in litt. 1997). Potential dietary selenium concentrations, from sampled aquatic insects, are within ranges toxic to small mammals (Olson 1986, Skorupa et al 1996), and could potentially adversely affect the shrew. Such effects could include, but may not be limited to, reduced reproductive output or premature death (Eisler 1985, Skorupa et al 1996). The Buena Vista Lake shrew also faces high risks of extinction from random catastrophic events (e.g. floods, drought and inbreeding). There are no known viable populations of Buena Vista Lake shrews outside the former Kern Lake Preserve for recolonization if a catastrophic event were to occur at this site. While the species still occurs within its limited range, it is not known whether or not the population is declining, how habitat conditions may be affecting the population, nor how small population size may be affecting genetic and behavioral stability.

Conservation Efforts.—Establishment of the Kern Lake Preserve, through an agreement between the owner, J.G. Boswell Company, and The Nature Conservancy provided protection of habitat for the Buena Vista Lake shrew and several candidate plant species from 1985 to 1995. The Nature Conservancy sponsored a population census for the species on the Preserve in 1988-1989 (Center for Conservation Biology 1990). More recently, USFWS sponsored a study to determine current status of the shrew at the Preserve and to try to locate other populations (J. Maldonado pers. comm.).

In 1994 and 1995, USFWS worked with the J.G. Boswell Company and The Nature Conservancy in an attempt to reverse The Nature Conservancy's decision to no longer manage the Preserve. USFWS has been working to develop a prelisting conservation agreement. Currently, there is an impasse: there is no conservation agreement for the property and no active management of habitat for the species that live there (J.A. Medlin in litt. 1995*b*).

Conservation Strategy.—The Kern Lake site should be preserved in perpetuity for the Buena Vista Lake shrew. In addition, greater efforts to locate and protect other extant populations of Buena Vista Lake shrews within the Tulare Basin are needed. Remnant patches of suitable habitat that might support the Buena Vista Lake shrew include areas within the Buena Vista Lake Aquatic Recreation Area, the Buena Vista Golf Course, and along the Buena Vista Slough, Goose Lake Slough and the Kern River west of Bakersfield (J. Maldonado pers. comm., Williams in litt. 1994). Additional areas of suitable moist locations that might provide remnant shrew habitat occur within the Pixley National Wildlife Refuge west of the former Tulare Lake bed, as well as around the former Goose Lake bed (Harris 1990). Areas south along Jerry Slough east of Buttonwillow Ridge may provide remnant shrew habitat as well (P. Collins pers. comm.).

Critical to conservation is the establishment of habitat that can support expansion and introduction efforts. Areas appropriate for habitat establishment include wetland areas within the Kern Water Bank Habitat Conservation Plan. Wetland creation and water conveyance facilities such as canals and ditches will provide habitat for this species, although it is unlikely that this habitat would become occupied in any other way than by deliberate introduction. Introductions would be under cooperative agreement with the resource agencies and Kern Water Bank Authority, or by other means (USFWS in litt. 1997*b*). Two other areas are the State Tule Elk Reserve near Tupman, another area where negotiations are underway to secure a permanent water supply (J. Single pers. comm.), and the Kern National Wildlife Refuge. Expansion of habitat, introduction efforts, and the protection of the Buena Vista Lake shrew should be an objective of any future National Wildlife Refuge and Ecological Reserve development and management plans.

The status of the Buena Vista Lake shrew should be reevaluated within 3 years of recovery plan approval.

7. Riparian Brush Rabbit
(Sylvilagus bachmani riparius)

Taxonomy.—The brush rabbit was described as *Lepus bachmani* by Waterhouse in 1838 and renamed *L. trowbridgii* by Baird in 1855, and redescribed with the currently accepted specific name of *Sylvilagus bachmani* by Lyon in 1904 (Larsen 1993). The species is found west of the Cascade-Sierra crest from the Columbia River to the tip of Baja California (Williams and Basey 1986). Thirteen subspecies of brush rabbit are recognized. The riparian brush rabbit, *S. b. riparius*, is one of eight subspecies found in California. It was described by Orr (1935) based on a specimen from the west side of the San Joaquin River about 3 kilometers (2 miles) northeast of Vernalis in Stanislaus County, California.

Description.—Brush rabbits are small, brownish rabbits that can be distinguished from their relative, the desert cottontail, by a smaller, inconspicuous tail and uniformly colored ears (no black tip) (Figure 66). The adult riparian brush rabbit is about 300 to 375 millimeters (10.58 to 13.23 inches) long, and can be distinguished from other subspecies by its relatively pale color, gray sides, darker back, and the fact that, viewed from above, its cheeks protrude outward rather than being straight or concave (Orr 1940).

Historical Distribution.—Historically, the riparian brush rabbit is believed, based on the presence of suitable habitat, to have been found associated with riparian forests along portions of the San Joaquin River and its tributaries on the Valley floor, from at least Stanislaus County to the Delta (Orr 1935).

Current Distribution.—By the mid-1980s, the riparian forest within the former range of the riparian brush rabbit had been reduced to a few small and widely scattered fragments, totaling about 2,100 hectares (5,189 acres). At 104.5 hectares (258.2 acres), Caswell Memorial State Park, on the Stanislaus River in southern San Joaquin County, is the largest remaining fragment of suitable riparian forest (Warner 1984) and home to the only extant population of riparian brush rabbit (Figure 67) (Williams and Basey 1986).

Food and Foraging.—Avoiding large openings in shrub cover, riparian brush rabbits frequent small clearings where they feed on a variety of herbaceous vegetation, including grasses, sedges, clover, forbs, shoots, and leaves. Grasses and other herbs are the most important food for brush rabbits, but shrubs such as California wild rose (*Rosa californica*), marsh baccharis (*Baccharis douglasii*), and California blackberry (*Rubus ursinus*) also are eaten. When available, green clover (*Trifolium wormskioldii*) is preferred over all other foods (Orr 1940).

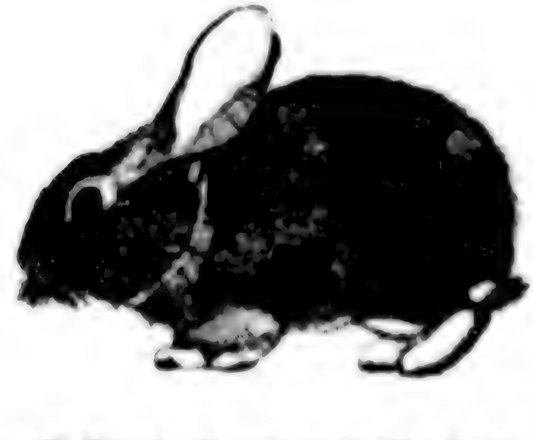

Figure 66. Illustration of a riparian brush rabbit. Drawing by Wendy Stevens (© CSU Stanislaus Foundation).

Reproduction and Demography.—Breeding of riparian brush rabbits is restricted to approximately January to May, putting this species at a competitive disadvantage to the desert cottontails outside the park that breed all year. Gestation is about 27 days, the usual litter size is three or four, and females produce three to four litters during the season. On average, a female may produce 9 to 16 young each year. Although this is a relatively high reproductive rate, it is lower than many other cottontail species, and five out of six rabbits do not survive to the next breeding season (Mossman 1955, Chapman and Harman 1972).

The population at Caswell Memorial State Park may have reached its lowest numbers after a flood in 1976, when survivors were removed to dry land from trees and shrubs by Park personnel in boats. After flooding in 1986, the population was estimated at between 10 and 20 individuals (Williams 1988). In 1993 the population was estimated by Williams (1993) at 213 to 312 individuals, and considered to be at carrying capacity under prevailing environmental conditions. Surveys were conducted in May 1997 after extensive winter flooding at Caswell State Park. Although one riparian brush rabbit was sighted, none were live-trapped. However, in the fall 1997/spring 1998 trapping session, one riparian brush rabbit male was live-trapped.

Behavior and Species Interactions.—Brush rabbits are closely tied to cover, and usually remain for several seconds to minutes just inside dense, brushy cover before venturing into the open. They seldom move more than a meter from cover, then remain motionless, watching for signs of danger. When pursued, they leap back into the cover of shrubs instead of heading into open ground (Chapman 1974). They will not cross large, open areas, and hence are unable to disperse beyond the dense brush of the riparian forest at Caswell Memorial State Park (Williams 1988).

The riparian brush rabbit can climb into bushes and trees, though its climbing is awkward and its abilities limited. This trait probably has significant survival value, given that the riparian forests that are its preferred habitat are subject to inundation by periodic flooding (Chapman 1974, Williams 1988).

Individuals are intolerant of each other when they come too close, but there is no well defined territoriality. Young are more tolerant of approach by another rabbit than are adults (Chapman 1974).

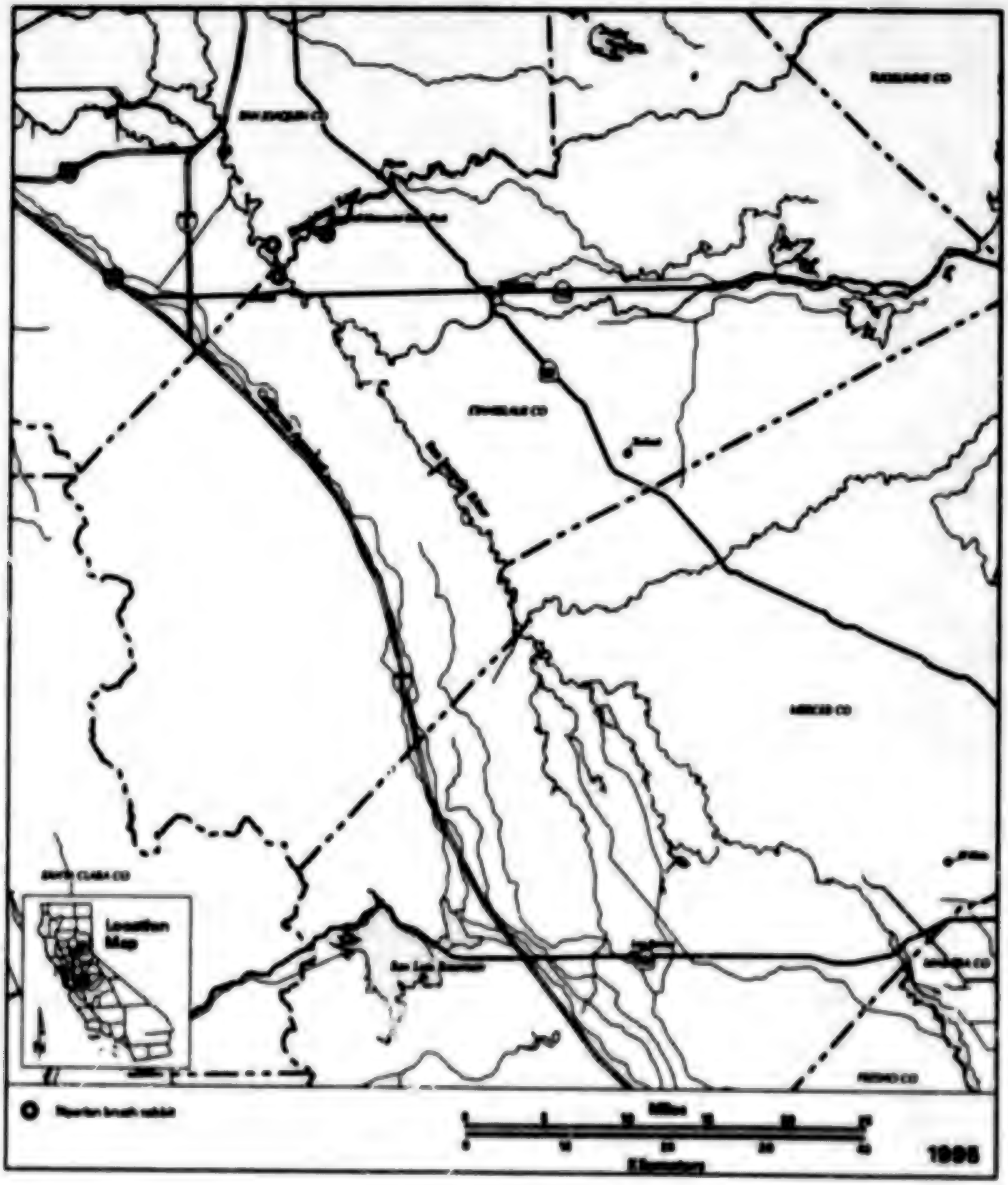

Figure 67. Distributional records for the riparian brush rabbit (*Sylvilagus bachmani riparius*).

When weather conditions are appropriate, individuals spend considerable time in the early mornings and afternoons on a log or a dry *form* (a resting place for a rabbit) basking in the sun. Favored basking sites are a few inches from cover no more than about 46 centimeters (18 inches) above ground, and protected by a partial, low-stratum canopy (Williams 1988, D.F. Williams unpubl. observ.).

Common mammalian associates of riparian brush rabbits are riparian woodrats, roof rats, western gray squirrels (*Sciurus griseus*), American opossums (*Didelphis virginiana*), striped skunks, feral cats (*Felis sylvestris*), gray foxes, coyotes, and feral dogs (Basey 1990, Williams 1988). Predators of riparian brush rabbits include red-tailed (*Buteo jamaicensis*), Swainson's (*B. swainsoni*), and red-shouldered hawks (*B. lineatus*), owls, feral cats, gray foxes, coyotes, and dogs.

Activity Cycles.—Riparian brush rabbits are most active during the twilight hours around dawn and dusk. Depending on season, the main activity periods last 2 to 4 hours. The least activity is from about 10:30 a.m. to 4:00 p.m. (Chapman 1974).

Habitat and Community Associations.—Riparian brush rabbits live in the brushy understory of Valley riparian forests. Forest with a closed canopy, however, generally lacks sufficient understory of shrubs for their needs. Where mats of low growing wild roses, wild grape (*Vitis californica*), and blackberries are found in *savanna*-like settings, brush rabbits live in tunnels through the vines and shrubs.

Sites inhabited by riparian brush rabbits usually have a mix of roses, blackberries, marsh baccharis, and grape vines, with high volumes of roses and coyote bushes (*Baccharis* sp.) in comparison to uninhabited sites. There are significantly more ground litter and surface area of roses and significantly fewer willows in the canopy and understory (none) at sites inhabited by riparian brush rabbits then sites occupied by desert cottontails. Presence of more surface litter and lack of willows in the understory signify areas of higher ground that are not flooded regularly or heavily (Williams and Basey 1986).

Reasons for Decline.—Two phenomena jointly have been the primary cause of the decline of the riparian brush rabbit. Both had their origin in the completion, beginning in the 1940s, of large dams for irrigation and flood control on the major rivers of the Central Valley. The first was the destruction and fragmentation of the San Joaquin Valley riparian forest by conversion to various urban and agricultural uses, and its degradation through a variety of other human activities. By the mid-1980s, this community had been reduced to only about 5.8 percent of its original extent. There probably is less today (Larsen 1993).

The second, more specific phenomenon was the conversion of land within the floodplains from shrub-dotted pasture land to vineyards, orchards, and row crops, with attendant land clearing and leveling, and the building and maintenance of levees. The land along rivers no longer exhibits the small patches of shrub-covered upland that once provided rabbits refuge from flooding and predation (Williams and Basey 1986, Williams 1988).

Threats to Survival.—The primary threat to the survival of the riparian brush rabbit is the limited extent of its existing habitat and the fact that there is only one extant population. Periodic flooding still occurs along all major rivers in the Valley (Kindel 1984). The increased predation to which these animals are exposed while taking refuge on cleared levees (Nolan 1984) or in exposed bushes or trees contributes directly to population decline and an elevated risk of extinction. With behavioral restrictions on its freedom of movement (low mobility) and the dearth of habitat suitably protected from frequent floods down-stream of Caswell Memorial State Park, there is little chance that individuals that escape drowning or predation will meet mates or reproduce.

The long-term suppression of fire in Caswell Memorial State Park, combined with prolonged drought, has caused the buildup of high fuel loads. The dense, brushy habitat to which the rabbits are restricted is thus highly susceptible to catastrophic wildfire that would cause both high mortality and severe destruction of habitat. Recovery of the riparian brush rabbit population from such a devastating event would be improbable.

Like most rabbits, the riparian brush rabbit is subject to a variety of common diseases, including tularemia, plague, myxomatosis, silverwater, encephalitis, listeriosis, Q-fever, and brucellosis. These contagious, and generally fatal, diseases could be transmitted easily to riparian brush rabbits from neighboring populations of desert cottontails (Williams 1988). In a widespread, genetically heterogeneous population, such an outbreak would be of minimal concern. However, in this small, remnant brush rabbit population, this kind of epidemic could quickly destroy the entire population.

Dependence on nearly continuous shrub cover, low mobility, and competition with the more fecund and mobile desert cottontail (Ingles 1941, Chapman 1971, Chapman and Willner 1978) are significant threats to the riparian brush rabbit in the ecotone communities between the riparian shrublands and the open, dry plant communities of the San Joaquin Valley (Williams 1986).

Given the biology and behavior of riparian brush rabbits and the smallness and highly fragmented distribution of the remnant of their habitat, natural dispersal cannot be expected. Thomas (1990) suggested that, to assure the medium- to long-term persistence of birds or mammals, the geometric mean of population size should be about 1,000 for species with normally varying numbers and about 10,000 for species exhibiting a high variability in population size. With its maximum population size limited by the size of its habitat well below either of these suggested minimums, the riparian brush rabbit population is at a high risk of imminent extinction from several consequent threats related to population genetics and dynamics and environmental variability.

Conservation Efforts.—In 1986, after surveys along rivers within its historical range indicated that there was only a single, small extant population in Caswell Memorial State Park (Williams and Basey 1986), the riparian brush rabbit was designated as a "Mammalian Species of Special Concern" by the CDFG's Wildlife Management Division. It was given Federal category-1 candidate status by USFWS in 1985 (USFWS 1985*d*) and remained a candidate for listing in USFWS's most recent Notice of Review (USFWS 1996). The riparian brush rabbit was proposed for listing by the USFWS on November 21, 1997 (USFWS 1997). The subspecies was listed as endangered by the State of California in May 1994 (Title 14, Division 1, California Administrative Code, Section 670.5, Animals of California declared to be endangered or threatened).

Besides the passive protection afforded to the species by the status of Caswell as a State Park, the California Department of Parks and Recreation funded a study of ecology and habitat management of riparian brush rabbits (Basey 1990, Williams 1988) and a small mammal inventory (Cook 1992). California Department of Parks and Recreation, Bureau of Reclamation, and USFWS, through the Endangered Species Recovery Program, funded a population assessment in the winter of 1993 and 1996–1997 (Williams 1993). The California Department of Parks and Recreation has expanded fire trails in Caswell Memorial State Park, which provides additional edge habitat for rabbits and better access to fight fires. The agency also has an on-going control program for feral animals, has curtailed ground-squirrel control (brush rabbits will eat treated bait meant for ground squirrels), and is involved in ongoing planning for habitat protection for wildlife in the park.

The only other management activity focused on the riparian brush rabbit at this time is a project to establish an experimental population on the Kings River in Fresno County, outside of the historical range of the subspecies. This effort was initiated when the Endangered Species Recovery Program suggested to the Bureau of Reclamation that establishing a population of riparian brush rabbits on public property along the Kings River could be one option for partially meeting their mitigation responsibilities under the Friant Biological Opinion. Besides Bureau of Reclamation, potential participants in this cooperative project include Caltrans, Endangered Species Recovery Program, Fresno County, COE and CDFG.

Conservation Strategy.—For optimal survival of riparian brush rabbits at Caswell Memorial State Park, expansion of the existing park and management of riparian brush rabbit habitat is necessary. Habitat management includes revitalizing decadent shrubs, reducing fire hazards, and providing refuges and reducing predation during periodic flooding. Park expansion, however, would require willingness from adjacent landowners to sell or dedicate the property for expansion of the riparian community, which has not been the case in the past, and may not be a practical option. Yet, even should this be achieved, expansion and enhancement of habitat of the park will not be sufficient to secure the survival of the species.

Important to conservation of the riparian brush rabbit is the establishment of other viable populations within its historical range. For successful establishment, studies on appropriate management, habitat restoration techniques, and reintroduction or introduction methods are important. Reintroduction methods may include researching genetic diversity among remaining individuals and implementing a captive breeding program. Potential translocation sites exist on State and Federal lands, and lands covered by Federal wildlife habitat easements along or adjacent to several stretches of the Stanislaus and San Joaquin Rivers. Until new populations are established, there must be close and constant vigilance to detect any immediate threat from fire, flooding, or disease and to allow emergency action to prevent extinction of the species.

The major problems with existing potential habitat outside Caswell Memorial State Park, including that with wildlife habitat easements and part of the National Wildlife Refuge system, are frequent flooding and lack of sufficient connected habitat (Williams and Basey 1986). A substantial amount of this property could become useable habitat for brush rabbits by providing protection from flooding. Dikes or raised areas with cover to shelter from high water, cessation of wood cutting, and stopping the removal of logs and limbs, and curtailment of livestock grazing are needed along several stretches of the Stanislaus River downstream from Caswell Memorial State Park.

An element in the conservation strategy is restoration of riparian habitat on Bureau of Reclamation property along the Kings River in Fresno County. This area is outside the historical geographic range of the riparian brush rabbit. Its importance is paramount, however, because there is not another site in public ownership that offers the potential for quickly restoring sufficient habitat to support a population. Establishment of a second population is important to prevent a single flood, wildfire, or other disaster from causing extinction of the rabbit.

Conservation Actions.— Because of the small size of remaining blocks of potential habitat, and the severely limited dispersal capability of the riparian brush rabbit, it is likely to require continuing special protection of its habitat and population. Realization of this limitation should remove barriers to the rapid establishment of as many populations in remnant habitat as possible, and sustaining those populations by reintroduction should any one become extinct. In furtherance of these objectives, the needed actions are:

1. Establish an emergency plan and monitoring system to provide swift action to save individuals and habitat at Caswell Memorial State Park in the event of flooding, wildfire, or a disease epidemic.

2. Develop and implement a cooperative riparian brush rabbit conservation program that will include, at a minimum:

   a. Identifying and obtaining biological information needed in management decisions; researching captive breeding methodology using surrogate species; conducting genetic composition analysis on the riparian brush rabbit population prior to any captive breeding or introduction/reintroduction (the objective is to ensure the establishment of new populations neither depletes the genetic diversity of the source population nor unduly restricts diversity in the newly established population); and implementing the captive breeding program.

   b. A riparian brush rabbit management plan for Caswell Memorial State Park that will incorporate elements detailed by Williams (1988; incorporated by reference) relating to predator and pest control; fire lines and access roads; campground, picnic, and recreation areas; brush and fuel control; mosquito abatement; habitat enhancement; and expansion of the Park.

   c. Establishment of at least three additional wild populations in the San Joaquin Valley, in restored and expanded suitable habitat within the rabbit's historical range.

   d. A monitoring program of all riparian brush rabbit populations to assess population trends and status.

   e. A long-term reintroduction preplan for the prompt re-establishment of eliminated populations.

   f. A cooperative program, to take effect once the minimum of four protected populations are established, to place excess young (or other animals as appropriate) from populations at carrying capacity onto private parcels with suitable habitat where owners are willing to enter into a management agreement.

8. Le Conte's Thrasher
(San Joaquin Valley Population)
(Toxostoma lecontei lecontei)

Taxonomy.—The genus Toxostoma is comprised of 10 species of thrashers, all of which are found in North America, including Mexico. Most thrasher species breed in the arid southwestern United States and northwestern Mexico. California species within the genus include Le Conte's thrasher *(T. lecontei)*, California thrasher *(T. redivivum)*, crissal thrasher *(T. crissale)*, and Bendire's thrasher *(T. bendirei)* (Peterson 1990). The type specimen of Le Conte's thrasher was described by Lawrence (1852) from a single specimen collected in Yuma County, Arizona by John L. Le Conte. The American Ornithologist's Union, in 1957, recognized two subspecies of *T. lecontei:* the desert thrasher *(T. l. arenicola)* of the west coast of Baja California, and Le Conte's thrasher (*T. l. lecontei*) of the San Joaquin Valley and Mojave and Colorado Deserts of California and Nevada southward into northeastern Baja California, Mexico, and points farther south; and the Sonoran Desert of Utah, Arizona, and Mexico. In 1965, based on plumage coloration, Phillips described the population of Le Conte's thrasher found in the San Joaquin Valley as *T. l. macmillanorum* from four birds collected near Buttonwillow, Kern County, California. Phillips (1965, according to Sheppard 1973) described the San Joaquin population as having a slightly darker crown than back, with slightly lighter sides, flanks, and breast when compared with the *T. l. arenicola*. A comparison of measurements between the *T. l. arenicola* and *T. l. lecontei* and the San Joaquin Valley population indicated no significant difference (Sheppard 1973), and Sheppard concluded that *T. l. macmillanorum* is a synonym of *T. l. lecontei*.

The San Joaquin Valley population apparently is isolated from other populations of Le Conte's thrasher and is resident; individuals do not migrate (Grinnell 1933*b*, Sheppard 1996). Sheppard (1973) suggested that the exchange of genetic material between the San Joaquin population and others probably does not occur. Recent DNA analysis (Zink and Blackwell as reported in Sheppard 1996) found no mtDNA sequence differences between the San Joaquin Valley population (*T. l. macmillanorum*) and other samples from the southwestern United States. The *T. l. macmillanorum* subspecies recognition, Sheppard suggests, should be withheld until some set of characters shows clear and abrupt divergence from west Mojave and Colorado desert populations.

Description.—The Le Conte's thrasher is a medium-sized songbird, about the same size as the northern mockingbird *(Mimus polyglottos)*. The total length and weights are nearly identical for both sexes: 240 to 280 millimeters (9.4 to 11 inches; Ridgway 1907) and 54.5 to 75.5 grams (1.9 to 2.6 ounces; Sheppard 1973). The Le Conte's thrasher has a plain grayish—or sandy—colored body without wing bars or spots.

Identification.—The Le Conte's thrasher (Figure 68) is distinguishable from songbirds other than thrashers by its long, nearly black, tail (about 12 centimeters, about 4.7 inches), and its distinctly-decurved black bill (about 2.7 centimeters, about 1 inch). The adult Le Conte's thrasher is distinguished from other thrashers by its unspotted breast, pale buffy crissum (undertail feathers), dark eye, lack of distinct superciliary stripe (above the eye), and dark tail contrasting sharply with the much paler body. The California and crissal thrashers are larger and darker. The California thrasher has a cinnamon crissum. The crissum of the crissal thrasher is a deep chestnut color (Sheppard 1996). The San Joaquin Valley population of Le Conte's thrasher has a slightly darker crown than back, and slightly lighter sides, flanks, and breast than the desert thrasher (Phillips 1965).

Historical Distribution.—Le Conte's thrasher occurs in two separate geographic areas: the Colorado and Mojave deserts down into Baja California, Mexico, where the species is widespread (Laudenslayer et al. 1992), and the southern San Joaquin Valley. Most Le Conte's thrashers are found between sea level and 1,150 meters (3,800 feet) (Sheppard 1973). The northernmost location for Le Conte's thrasher was Mono County, California; the southernmost was on the west coast of

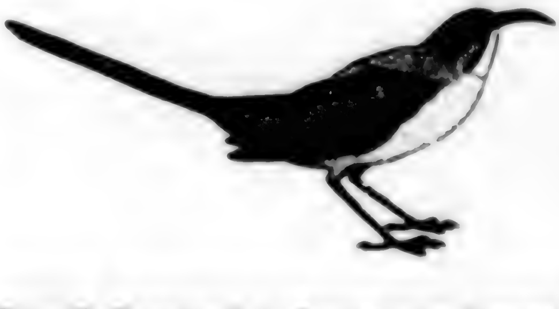

Figure 68. Illustration of a Le Conte's thrasher. Drawing by Wendy Stevens (© CSU Stanislaus Foundation).

Baja California. The historical range for the San Joaquin Valley population of Le Conte's thrasher included the west side of the San Joaquin Valley, from the Panoche Mountains, Fresno County, in the north, to Maricopa, Kern County, in the south (Figure 69) (Dobkin and Granholm 1990). Grinnell (1933*b*) used a reverse "J" shape to describe the range: the northern extent stopped at Huron, the valley floor of the San Joaquin Valley was excluded, and neither the Carrizo Plain nor Cuyama Valley were included. Sheppard (1970 and 1973) added the Carrizo and Cuyama based on his personal observations, added the Valley floor based on specimens near Wasco collected after Grinnell, and added the Panoche Mountains based on an observation by a birder.

Current Distribution.—The current distribution of the San Joaquin Valley population of Le Conte's thrashers is determined largely by the presence, structure, and vigor of saltbush, proximity to other saltbush areas, size of habitat fragment, and presence of California thrashers. The picture is of a complex of islands with relatively insurmountable distances of unsuitable habitat separating them. Irrigation and land development have eliminated a considerable amount of former habitat in the San Joaquin Valley, restricting the San Joaquin Valley population of Le Conte's thrashers to a small portion of its former range (Laudenslayer et al. 1992). There are five known and one potentially extant population areas. Each area is a mosaic of habitats ranging from unsuitable to fair habitat (only two of the five areas have good to excellent habitat). A brief discussion of each area follows:

1. McKittrick - Maricopa. This area extends from Belridge just north of McKittrick, south to Devil's Gulch south of Maricopa, east to the California Aqueduct between Lokern Pumping Station and Pentland, and west to the lower third of the Temblor Mountains. This is by far the largest and best habitat area. The highest concentrations of Le Conte's thrasher are near McKittrick and Maricopa. The southwest corner of the Belridge oil field has several hundred acres of good habitat. Several pairs of thrashers persisted here through the drought. However, areas of unsuitable nesting habitat exist. In early May 1997, a wildfire burned 40,000 acres in the area known as the Lokern, including burning half of a grazing experiment study area. On 22 July 1997, USBLM burned another 1,000 acres on the Lokern Study Area to keep the 4 square mile experimental area similar. Bird data gathered just prior to the fire in 1997 documented Le Conte's thrashers adjacent to seven of eight plots while none were detected in April and May of 1998. Observations of Le Conte's thrashers several miles from the study plots indicate that the lack of observations in 1998 in the study area is likely a result of the nearly complete mortality of saltbush (charred skeletons remain) and not a decline of the species in the local area (S. Fitton pers. comm.).

2. Lost Hills. This area extends north from Highway 46 for less than 9.6 kilometers (6 miles) with the California Aqueduct as the eastern boundary. Habitat patches are small and highly fragmented with probably fewer than 20 pairs of thrashers. Significant distances of plowed ground separate this subpopulation from the Maricopa and Kettleman Hills subpopulations.

3. Kettleman Hills. This area is from Highway 41 north to almost Jayne Road. The eastern boundary is Interstate 5, and western boundary is the near Highway 33. There is little good habitat in the Kettleman Hills, probably supporting fewer than 20 pairs. In the 1960s, J. M. Sheppard (pers. comm.) estimated this subpopulation to be 200 pairs. This area is now entirely surrounded by plowed ground, however, there is good potential for habitat improvements on all the domes of the Kettleman Hills and the adjacent alluvial fans. Without grazing, the Kettleman Hills accumulate a thick and tall mulch that is generally avoided by Le Conte's thrashers. (Note: A 8,100 hectare (20,000 acre) wildfire, started from Interstate 5 in 1995, typifies the threat of fire to this species' habitat. The fire destroyed most of the occupied habitat on the Middle Dome of the Kettleman Hills leaving habitat on only about half of the North Dome from about Skyline Boulevard, State Route 269, north to end of the hills (S. Fitton pers. comm.)

4. Carrizo - Elkhorn Plain. This area is composed of two subunits. One is the Elkhorn Plain, extending from Wallace Creek in Panorama Hills on the north, south to Beam Flat. The other subunit is within the southern end of the Carrizo

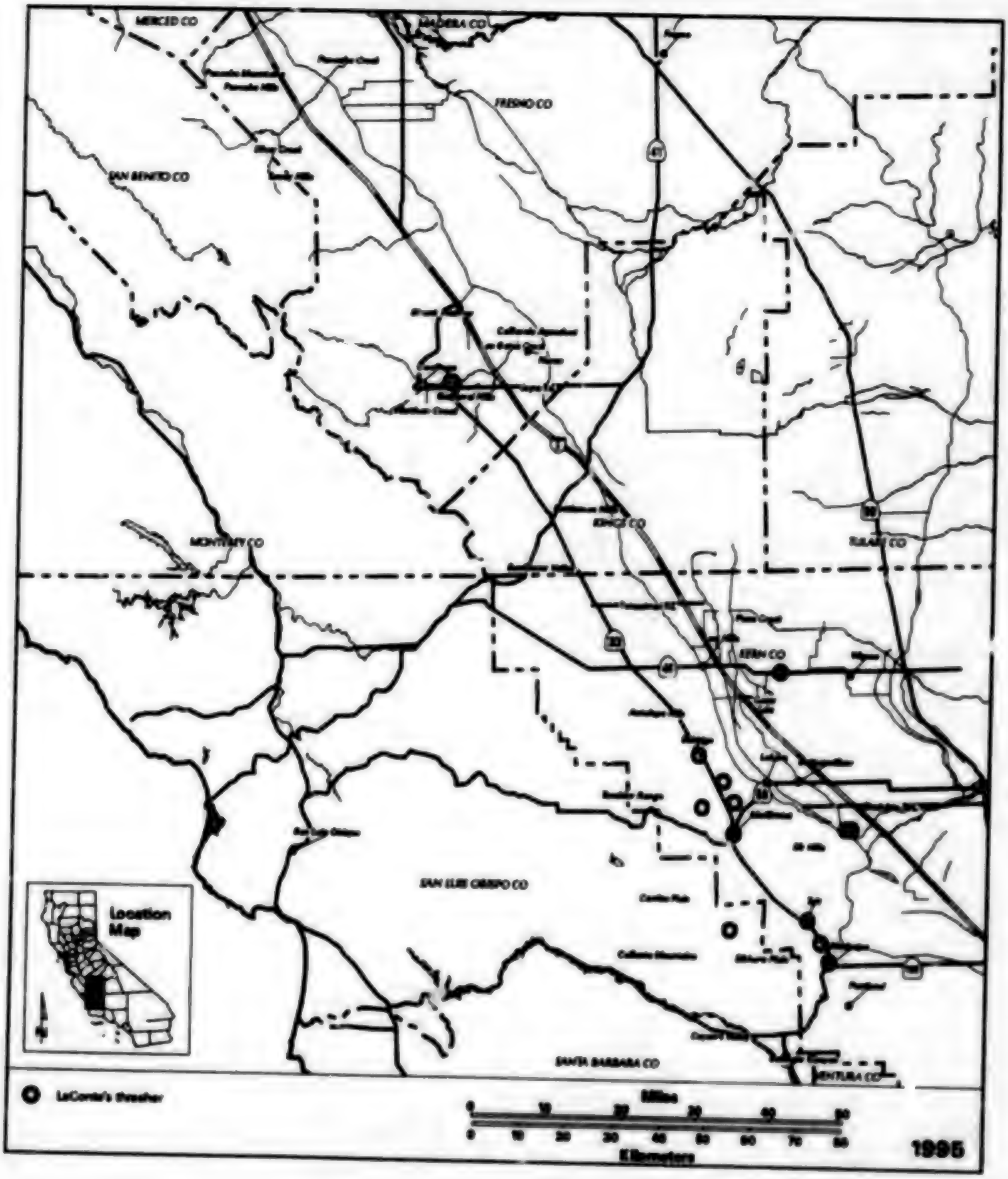

Figure 69. Distributional records for the San Joaquin Valley population of Le Conte's thrasher (*Toxostoma lecontei lecontei*).

Plain. The birds of these two subunits probably come into contact with each other as well as with Le Conte's thrashers from the McKittrick - Maricopa area. They may also come in contact with the Cuyama area birds. The Carrizo - Elkhorn Le Conte's thrashers overlap with California thrashers.

5. Cuyama Valley. Since the time Sheppard (1970) first found Le Conte's thrashers in Cuyama Valley, much of the habitat has been overgrazed or converted to agriculture (J. Sheppard pers. comm., S. Fitton pers. comm.) Now, after extensive surveying, the species is only found in a small area dominated by ephedra, from the mouth of Ballinger Canyon north to CA Highway 166. Many areas now seem to support California thrashers. There are probably fewer than 10 pairs of Le Conte's thrashers in the Cuyama Valley (S. Fitton and L. Saslaw unpubl. observ.). If the alluvial fans east of CA Highway 33 [illegible] to native shrublands, Le Conte's thrashers would no doubt respond by expanding into the habitat. Le Conte's thrashers in the Cuyama Valley are surrounded by excellent, occupied California thrasher habitat as well as a nearly continuous, narrow belt of California thrasher habitat along the Cuyama River.

6. Panoche Mountains. Recent surveys, from 1989 to 1998, have not located Le Conte's thrashers north of Kettleman Hills (S. Fitton unpubl. observ.). While some of the habitat looks suitable, only California thrashers have been seen recently. It is possible that Le Conte's thrashers occur in the Panoche Mountains at very low numbers and isolated from other subpopulations.

Other areas that historically have had Le Conte's thrashers or appear to be suitable and have been surveyed over several years, 1989 to 1998, without success are: Panoche Hills, Panoche/Silver Creeks, Tumey Hills, Antelope Hills, Sunflower Valley, alluvial fans on the south side of Caliente Mountain, portions of the Carrizo Plain, Warthan Creek, Los Gatos Creek, Guijarral Hills, Skunk Hollow, Poso Creek north of Bakersfield, and isolated patches of saltbush along Interstate 5 from Stockdale Avenue north to Twisselman Road (S. Fitton and L. Saslaw unpubl. data).

Food and Foraging.—The Le Conte's thrasher occupies a highly specialized niche within the ecosystem (Sheppard 1973). The Le Conte's thrasher forages in the leaf litter under saltbush plants, on the ground surface, or 5 to 7.6 centimeters (2 to 3 inches) into the substrate for arthropods, including scorpions, spiders, beetles, grasshoppers, and butterfly and moth larvae. Occasionally, this species will feed on seeds, small lizards, or other small vertebrates (Bent 1964, Sheppard 1970). Le Conte's thrashers are not known to drink water; their diet is their only source of water (Sheppard 1970).

Reproduction.—Singing starts in mid-autumn and peaks in late December and January, as nest building begins. The species is not migratory and pairs remain together throughout the year. Mated pairs appear to have site fidelity until one bird dies. Thick, dense, and thorny desert shrubs (such as saltbush) are preferred for nesting sites (Sheppard 1996). Such plants are often along well established drainages, or are older, well formed plants on upland sites. Le Conte's thrashers do not use habitats without this structure (S. Fitton unpubl. data).

The breeding season for Le Conte's thrasher begins in late January and extends through early June, with the peak ranging from mid-March to mid-April. This species may have up to three broods during the reproductive season. Clutch size is usually 3 or 4 eggs (range 2 to 5). Eggs are incubated for 14 to 20 days by both parents. Young fledge 12 to 20 days after hatching, with the male continuing to feed the young if the female is incubating the next clutch. At approximately 30 days old, fledglings disperse approximately 400 meters (1,300 feet). Dispersal movements may continue until the young are clear of occupied territory (Sheppard 1970, 1996). Based on dispersal of young, it is estimated that if isolated habitat fragments are greater than 10 to 15 kilometers (6 to 9 miles) apart, colonization or recolonization may be precluded (S. Fitton as reported in Sheppard 1996).

Demography.—Grinnell (1933*b*) estimated 2.3 pairs per square kilometer (less than 1 pair per square mile) near McKittrick, Kern County, California during late February and March, when adults are less obvious. Average January density at Maricopa was 4.6 pairs per square kilometer (12 pairs per square mile) (Sheppard 1996). San Joaquin Valley Le Conte's thrashers banded near Maricopa used from 20 to 50 hectares (50 to 125 acres) per pair over 1 year (Sheppard 1973). Home range may vary in size and shape depending on time of year and interactions with neighbors. It is estimated that about 7 hectares (18 acres) are needed per pair for nesting territory (Sheppard 1970). Since the late 1960s, densities of the San Joaquin Valley population of Le Conte's thrasher have declined except in a few core areas (Laudenslayer et al. 1992).

Behavior and Species Interactions.—The Le Conte's thrasher is a resident species, remaining year round in suitable habitat. In general, the Le Conte's thrasher is a terrestrial bird, running among shrubs rather than flying. Flying occurs irregularly, such as during nest building and when bringing food to the young. The Le Conte's thrasher is highly territorial through much of the year. Males become less territorial during the summer months when they are molting and young are dispersing. The territory is most actively defended between early December and early February (Sheppard 1970, S. Fitton unpubl. data).

Potential competitors for food and nesting sites include California thrasher, sage thrasher *(Oreoscoptes montanus)*, northern mockingbird, loggerhead shrike *(Lanius ludovicianus)*, and greater roadrunner *(Geococcyx californianus)* (Sheppard 1973). At Maricopa, California, San Joaquin Valley Le Conte's thrashers and loggerhead shrikes often nest within 20 meters (65 feet) of each other (Sheppard 1973). Species known to prey upon the eggs, young, and adults of Le Conte's thrashers include hawks, owls, greater roadrunners, antelope ground squirrels, cats, dogs, coyotes, and various species of snakes (Sheppard 1973).

Activity Cycle.—The San Joaquin Valley Le Conte's thrasher is active during daylight, throughout the year. Little or no activity takes place during periods of higher temperatures (above 35 to 38 degrees Celsius [95 to 100 degrees Fahrenheit]) (Sheppard 1970).

Habitat and Community Associations.—Le Conte's thrashers are generally found in open desert scrub, alkali desert scrub, and desert succulent scrub. In the San Joaquin Valley, the species is found primarily in habitats dominated by saltbush, and often frequents desert washes and flats with scattered saltbush (Laudenslayer et al. 1992). Nesting habitat mainly is in taller, bushier shrubs. Sheppard (1970, 1973) found San Joaquin Le Conte's thrashers most commonly associated with sandy and alkaline soils, but believed that, except for texture, soils had little direct effect on the distribution of the species.

Within the Maricopa region, Le Conte's thrashers are in contact with California thrashers wherever patches of willow and/or big saltbush are found, and along the foothills of the Temblor Mountains wherever the slope increases and eastwoodia and narrowleaf goldenbush begin to dominate on north-facing slopes. California thrashers occupy moister and shadier locations (even as a microclimate).

Reasons for Decline.—Habitat degradation and loss to agriculture, urbanization, oil and gas development, fire, and over-grazing by livestock are the primary reasons for decline of the San Joaquin Valley population of Le Conte's thrasher (Laudenslayer et al. 1992). Pesticides may have historically been responsible for nesting failure. In Maricopa several clutches from 1968 to 1971 failed to hatch and DDT and DDE poisoning were suspected (P. Owens as reported in Sheppard 1996). Prior to the 1972 ban, DDT spraying was conducted in this area each winter.

Threats to Survival.—Because of the San Joaquin Valley Le Conte's thrasher's limited mobility and susceptibility to habitat fragmentation and degradation, it is vulnerable to becoming isolated and eventually disappearing from a nesting area. The loss of expansive areas of suitable nesting and foraging areas is a considerable threat to the population of Le Conte's thrasher within the San Joaquin Valley. Though a significant amount of saltbush-dominated communities has been converted to agricultural land use, there remains substantial acreage of annual rangelands on the west side of the San Joaquin Valley that may be suitable for this species. Whether these habitats are occupied depends on the structure of the saltbush overstory, the size of the habitat patch, and the connectivity among habitat patches.

Much of the remaining habitat is predominately used for livestock grazing and petroleum production. Suitable saltbush structure can be eliminated by heavy livestock grazing which mechanically damages plants and reduces leaf litter. Many acres of suitable habitat have been eliminated through grazing practices that remove saltbush structure or restrict seedling establishment. However, suitable habitat can be reestablished with modification of livestock grazing practices that allows for seedling establishment and the development of plants greater than 1.5 meters (4.9 feet) in height and scattered across the landscape. As was evidenced in the Carrizo Plain following reestablishment of saltbush, Le Conte's thrasher will recolonize new saltbush stands.

Wildfires that burn large acreages of saltbushes eliminate suitable Le Conte's thrasher habitat. The duration of such habitat loss may depend on fire frequency, climatic conditions that favor saltbush reestablishment, and livestock grazing practices. While fire kills saltbushes (D. Germano and L. Saslaw unpubl. data), the site can be repopulated with saltbushes under favorable climatic conditions and compatible grazing practices (S. Fitton unpubl. data).

Dense cover of herbaceous vegetation, especially introduced annual grasses and filaree that result in thick mats of dead vegetation, reduce foraging habitat for this species and increases the risk of wildfire.

Oil and gas development continue to be a threat. Intensive petroleum development that eliminates all vegetative cover over large acreage eliminates Le Conte's thrasher habitat. However, light and moderate petroleum activities that maintain the saltbush community between wells and facilities, and tall saltbushes along drainages, do provide substantial habitat for this species. Most of the oil fields in the western foothills of the southern San Joaquin Valley provide suitable thrasher habitat. Oil sumps not properly maintained have proven fatal to young and adults who become entrapped (Sheppard 1996).

Brood parasitism by cowbird species (*Molothrus spp.*) has not been widely noted, however, S. Rothstein (as presented in Sheppard 1996) tested active Le Conte's thrasher nests at Maricopa, to artificial introduction of brown-headed cowbird (*Molothrus ater*) eggs. All of the eleven thrasher pairs in the experiment accepted these eggs as their own.

Conservation Efforts.—The San Joaquin Valley population of Le Conte's thrasher is not a candidate for Federal listing, but is considered a species of concern (USFWS 1996). It is also a California Species of Special Concern (Remsen 1978). No areas of habitat have been set aside specifically for this thrasher. However, conservation areas such as the Carrizo Plain set aside for other species in jeopardy (e.g., San Joaquin kit fox, giant kangaroo rat, blunt-nosed leopard lizard, etc.) also have benefited this species.

The maintenance of saltbush communities has been identified as a management objective in the Carrizo Plain Natural Area, Elk Hills Naval Petroleum Reserves in California, on USBLM lands in western Fresno, Kings, Kern and San Luis Obispo Counties, and at the Lokern Area. The maintenance of saltbushes in drainage channels and conservation of natural lands in the oil fields are also being addressed in the Habitat Conservation Plans. However, the lands in conservation programs are a small percentage of the available habitat.

Conservation Strategy.—A systematic review, distributional survey, and population monitoring of the San Joaquin Le Conte's thrasher are needed to clarify the bird's distributional and population statuses, potential threats of endangerment (Laudenslayer et al. 1992), and listing status.

Maintenance of the saltbush communities in the oil fields will be a key component for conservation. Management practices that avoid saltbush drainages, minimize habitat disturbance, and promote reclamation of degraded saltbush communities will aid in conservation. Reintroduction of Le Conte's thrashers into patches of suitable saltbush larger that 405 hectares (1,000 acres) should be investigated.

Maintenance of remaining saltbush communities and connecting fragmented stands of suitable habitat in southwestern Kern County would significantly reduce the threats to this species. Annual rangelands found on deeper alluvial soils that are capable of supporting tall stands of common saltbushes should be promoted on public and private rangelands. Grazing management practices that aid in the establishment and maintenance of common saltbush on suitable sites should be introduced to livestock producers for management and economic evaluation. Appropriate grazing management practices on Federal, CDFG and other conservation lands should be implemented to maintain suitable saltbush and herbaceous structure. Key conservation areas include the Naval Petroleum Reserve in California #2, Occidental of Elk Hills, Lokern Area, USBLM lands around Taft and Maricopa, and the Elkhorn Plain. If such provisions are included and implemented in upcoming Habitat Conservation Plans, long-term conservation probably can be achieved.

The status of the San Joaquin Valley population of the Le Conte's thrasher should be reevaluated within 5 years of recovery plan approval or when new information is available, whichever is less.

III. RECOVERY

A. OBJECTIVES

The overall objectives of this recovery plan are to delist California jewelflower, palmate-bracted bird's-beak, Kern mallow, Hoover's woolly-star, San Joaquin woolly-threads, Bakersfield cactus, giant kangaroo rat, Fresno kangaroo rat, Tipton kangaroo rat, blunt-nosed leopard lizard, and San Joaquin kit fox; and achieve the long-term conservation of lesser saltscale, Bakersfield smallscale, Lost Hills saltbush, Vasek's clarkia, Temblor buckwheat, Tejon poppy, diamond-petaled California poppy, Munz's tidy-tips, Comanche Point layia, Jared's peppergrass, Merced monardella, Merced phacelia, oil neststraw, Ciervo aegialian scarab beetle, San Joaquin dune beetle, Doyen's dune weevil, San Joaquin antelope squirrel, short-nosed kangaroo rat, riparian woodrat, Tulare grasshopper mouse, Buena Vista Lake shrew, riparian brush rabbit, and San Joaquin Le Conte's thrasher and other members of biotic communities occupied by the listed species in the San Joaquin Valley planning area.

Interim goals are to stabilize and protect populations and to conduct research necessary to refine reclassification and recovery criteria and subsequently reclassify California jewelflower, palmate-bracted bird's-beak, Kern mallow, San Joaquin woolly-threads, Bakersfield cactus, giant kangaroo rat, Fresno kangaroo rat, Tipton kangaroo rat, blunt-nosed leopard lizard, and San Joaquin kit fox from endangered to threatened. Reclassification will be appropriate when each taxon is no longer in danger of extinction throughout a significant portion of its range.

1. Ecosystem-Level Strategy

To meet the objective of delisting 11 species and ensuring long-term conservation of 23 other species, this recovery plan uses an ecosystem-level strategy. This strategy establishes a network of reserves and conservation areas that represents all natural communities in San Joaquin upland ecosystems. Of necessity, the ecosystem-level strategy is shaped by the realities of existing communities; by available information on biology, distribution, and population statuses; and by the current and anticipated processes that will affect both natural and human-altered landscapes. The strategy has 10 major elements:

a. The primary focus of recovery processes is on publicly-owned lands whenever possible. Where conservation of a species requires preservation of private lands, it will be necessary to seek cooperation from private individuals and entities to sell lands or easements, or, to enter into cooperative (voluntary) programs to maintain and enhance habitat values for certain species while traditional uses of the land continue. Cooperative programs are emphasized over land acquisition or easements.

b. Wherever possible conservation efforts are focused on fewer, larger blocks of land rather than smaller, more numerous parcels. Several advantages to this approach are enumerated by the San Joaquin Valley Biological Technical Committee (in litt. 1993). The most important are that larger natural areas provide greater species and physical diversities and larger, less vulnerable species populations; minimize edge between natural and developed land thereby reducing pest and other problems at this boundary; and reduce management costs.

c. Wherever possible and needed, blocks of conservation lands should be connected by natural land or land with compatible uses that allow for movement of species between blocks.

d. Greater emphasis is placed on two groups of species as defined below:

    1. ***Umbrella Species***. The San Joaquin kit fox occurs in nearly all the natural communities used by other species featured in this plan, but these others are much more restricted in their choice of habitats. The broad distribution and requirement for relatively large areas of habitat mean conservation of the kit fox will provide an umbrella of protection for many other species that require less habitat. Therefore, the San Joaquin kit fox is an umbrella species for purposes of this recovery plan. Many of its habitat management and research needs are given higher priority in recovery actions at the

ecosystem level than those of other species because it is one of the species that will be hardest to recover. Fulfilling the San Joaquin kit fox's habitat management and research needs also meets those of many other species.

2. ***Keystone Species***. The giant kangaroo rat and, to a lesser extent, the subspecies of the San Joaquin kangaroo rat are keystone species in their communities (Shiffman 1994, Goldingay et. al. 1997). In most places where they occur, the *precincts* (area over and immediately around the burrow system) of giant kangaroo rats dominate the landscape. The activities of these animals promote more nitrogen-rich and abundant growth of plants on the precincts (Williams et al. 1993*b*). Their burrowing modifies the surface topography of the landscape and changes the mineral composition of the soil. Their burrows provide refuges and living places for many small animals, including blunt-nosed leopard lizards and San Joaquin antelope squirrels (Williams and Kilburn 1991). Their seed caching behaviors disperse and plant seeds and alter the floral composition of the community (Schiffman 1994). Their precincts provide a favored microhabitat for the growth of California jewelflowers and San Joaquin woolly-threads (Cypher 1994*a*).

   Giant kangaroo rats are the most abundant mammal in their community, and are the favored prey of San Joaquin kit foxes and many other predators (Williams 1992). The San Joaquin kangaroo rat has a similar but less dramatic role in its communities (Williams 1985). The giant kangaroo rat and San Joaquin kangaroo rat, therefore, are considered to be keystone species in this recovery plan. Protection of these keystone species is a high priority because they provide important or essential components of the *biological niche* (meaning all the physical and biological factors required for a particular species to live, and its way of living) of some other listed and candidate species.

e. Wherever and whenever possible, management of habitat for featured species should be achieved in harmony with traditional land uses and processes such as seasonal livestock grazing, low impact petroleum and mineral exploration and extraction, and hunting and wildland recreation.

f. For species vulnerable to traditional land uses, and for those with highly restricted geographic ranges and specialized habitat requirements, there is no recourse but to appropriately manage their existing habitat in smaller, specialty reserves of natural land, both within larger conservation areas and as small reserves surrounded by developed land.

g. Existing natural lands occupied by featured species are targeted for conservation in preference to unoccupied natural land and retired farmland. This goal greatly reduces or eliminates the need for expensive and untested restoration work to make the land suitable for habitation by these species.

h. Species for which sufficient, occupied natural land does not exist, but is needed to increase population size or promote movement between populations, can be recovered by carefully coordinating agricultural land retirement programs with endangered species recovery. Directing the location and size of blocks of retired farmland can contribute greatly to the potential success of recovery of some species while minimizing costs and conflicts with other land uses.

i. For species such as the San Joaquin kit fox that can live in or move through the farmland matrix, enhancement of those features of the landscape that engender successful living and movements from population centers on the larger islands of natural lands on the Valley floor to the Valley's perimeter will greatly enhance the chances of recovery. This linkage can be accomplished in part through a *safe harbor program* that promotes and enhances populations of some species on and movements through farmland while permitting incidental take of listed species by farming activities (Hawkins 1995, Keystone Center 1995). A safe harbor program was recently proposed for the San Joaquin Valley by the American Farmland Trust (Scott-Graham 1994). The Endangered Species Recovery Program has collaborated with the American Farmland Trust in proposing a focused safe harbor program featuring the San Joaquin kit fox. This focused program is a critical element of the recovery strategy.

j. This recovery strategy is complementary wherever possible with ongoing Habitat Conservation Plans and provides guidance to local governments in the development of new Habitat Conservation Plans.

This ecosystem-level strategy is in large part based on the biological imperatives for recovery of the San Joaquin kit fox, the umbrella species for this recovery effort. Section II.L.6 expands on this species' recovery goal: establishment of a viable kit fox metapopulation through protection and management of a system of core and satellite populations on public and private lands throughout its range. Recovery of the kit fox will not automatically lead to recovery of all other sensitive species in San Joaquin Valley ecosystems. However, it provides a blueprint for ecosystem recovery that will be complemented by specific recovery actions on natural communities for species with special needs that have little relationship to kit fox recovery needs. Implementation of this strategy retains the advantages of ecosystem-level conservation: involving all segments of society in recovery actions; preserving all or most species simultaneously; saving effort and money; and increasing the chances that recovery efforts will succeed.

B. Recovery Criteria

Recovery criteria for listed plant and animal species are summarized in Table 4. Site-specific protection requirements to meet these delisting criteria are summarized in Table 5. Measures to ensure conservation of candidate species and species of concern are listed in Table 6. For several of the species featured in this plan, one or more categories of information needed to set firm recovery or conservation criteria are not available, necessitating interim criteria of stabilizing existing populations and conducting research necessary to determine reclassification or delisting criteria.

In Table 4, progress of species in achieving population goals depends on monitoring showing "stability" or "increasing numbers" during a precipitation cycle, which is a period when annual rainfall includes average to 35 percent above-average through greater than 35 percent below-average and back to average or greater. The direction of change (average to above or below average) is unimportant in this criterion. Existing data for some arid-land species show that both drought and periods of above-average precipitation cause severe population declines if extended for more than 1 year (Endangered Species Recovery Program, unpubl. data). Because the populations of most or all species included here fluctuate dramatically, *stability* is a relative term meaning the statistically same population size during the average phase of a precipitation cycle (anticipated to be about 20 years). *Increasing population size* means that the population has increased over the previous or baseline year, measured during the specified portion of a precipitation cycle. Range wide population monitoring programs will have to be established for all species to measure progress in meeting recovery criteria. For species with existing data on population statuses spanning 1 or more years, these data can be included in measuring population recovery goals if it is deemed scientifically valid and representative. Thus, some species can be downlisted or delisted quickly once other criteria, such as habitat protection, are met.

Listed Plant Species.—Delisting criteria for the plant species currently listed as endangered include requirements for protecting additional habitat, assurances that protected sites are being managed appropriately, and monitoring to show stable or increasing populations. Attainment of downlisting or delisting criteria does not automatically qualify a species for reclassification. A status review must be conducted after the criteria have been met to determine whether or not reclassification is appropriate.

Plant Species of Concern.—Existing information for the species of concern is insufficient at this time to determine whether or not they qualify for listing as endangered or threatened. Thus, the actions necessary for these species include surveys in suitable habitat and evaluation of threats. In certain cases, management actions are recommended to counter known threats and stabilize populations. Additional information on species of concern also can be collected during field surveys.

TABLE 4. ***Generalized Recovery Criteria for Federally-Listed Plants and Animals.***

Though not explicitly stated, delisting criteria include meeting all of the downlisting criteria. Range-wide population monitoring should be provided for in all management plans. See individual species accounts for discussion of recovery strategy and the introduction to this section for a discussion of the bases of the criteria.

Species	Recovery Step	Secure and protect specified recovery areas from incompatible uses	Management Plan approved and implemented for recovery areas that include survival of the species as an objective	Population monitoring in specified recovery areas shows:
California jewelflower	***Downlist to threatened***	Ninety-five percent of occupied habitat on public lands; 75 percent of population and occupied habitat in Santa Barbara Canyon	For all protected areas identified as important to continued survival	Stable or increasing populations through precipitation cycle
	Delist	Ninety percent of population and occupied habitat in Santa Barbara Canyon, one population each on the San Joaquin Valley floor and eastern Valley foothills	For all protected areas identified as important to continued survival	No decline after downlisting, if declining, determine cause and reverse trend
palmate-bracted bird's beak	***Downlist to threatened***	Ninety-five percent of occupied habitat on public land; 75 percent or more of population and occupied area and upland nesting habitat for pollinators within 300 meters (984 feet) of the population margins at Springtown Alkali Sink; two or more populations in the San Joaquin Valley	For all protected areas identified as important to continued survival	Stable or increasing populations through precipitation cycle
	Delist	Eight or more distinct populations, including two or more in the San Joaquin Valley, 90 percent or more of the Springtown Alkali Sink population and habitat	For all protected areas identified as important to continued survival	No decline after downlisting, if declining, determine cause and reverse trend
Kern mallow	***Downlist to threatened***	Ninety-five percent of occupied habitat on public lands; 75 percent of population and 75 percent of occupied habitat in Lokern	For Lokern Area	Stable or increasing populations through precipitation cycle
	Delist	Ninety percent or more each of population and occupied habitat in Lokern; two or more distinct populations outside the Lokern Natural Area	For all protected areas identified as important to continued survival	No decline after downlisting, if declining, determine cause and reverse trend
Hoover's woolly-star	***Delist***	Seventy-five percent of occupied habitat on public lands in each of the four metapopulations; 260 hectares (640 acres) or more of occupied habitat on San Joaquin Valley floor	For all protected areas identified as important to continued survival	Stable or increasing in four metapopulations and San Joaquin Valley floor population through one precipitation cycle, if declining, determine cause and reverse trend

TABLE 4. (*continued*). ***Generalized Recovery Criteria for Federally-Listed Plants and Animals.*** *Though not explicitly stated, delisting criteria include meeting all of the downlisting criteria. Range-wide population monitoring should be provided for in all management plans. See individual species accounts for discussion of recovery strategy and the introduction to this section for a discussion of the bases of the criteria.*

Species	**Recovery Step**	**Secure and protect specified recovery areas from incompatible uses**	**Management Plan approved and implemented for recovery areas that include survival of the species as an objective**	**Population monitoring in specified recovery areas shows:**
San Joaquin woolly-threads	***Downlist to threatened***	Ninety-five percent of occupied habitat on public land	For all protected areas identified as important to continued survival	Stable or increasing in all protected areas through one precipitation cycle
	Delist	Two hundred and sixty hectares (640 acres) or more of occupied habitat in the Lost Hills; one or more other sites on San Joaquin Valley floor of 260 hectares (640 acres) or more	For all protected areas identified as important to continued survival	No decline after down listing, if declining, determine cause and reverse trend
Bakersfield cactus	***Downlist to threatened***	Ninety-five percent of the occupied habitat on public land; 75 percent of Bakersfield cactus clumps and 75 percent of the occupied habitat in the Caliente-Bena Hills, Comanche Point, Kern Bluff, Sand Ridge, and Wheeler Ridge areas	For all protected areas identified as important to continued survival	Stable or increasing populations at all protected sites for a 5-year period
	Delist	Ninety percent of existing clumps and occupied habitat in the above-specified areas, and the Fuller Acres, Cottonwood Creek, Granite Station, and Kern Canyon populations, 100 or more clumps each in other populations north and south of the Kern River	For all protected areas identified as important to continued survival	All protected populations show evidence of reproduction
giant kangaroo rat	***Downlist to threatened***	All occupied lands in Carrizo Plain Natural Area and Ciervo-Panoche Natural Area, western Kern County areas, as specified in recovery strategy	All protected areas identified as important to continued survival including the Carrizo Plain Natural Area	During 5-year period no greater than 20 percent change in population size during years without drought or greater than 35 percent above average precipitation
	Delist	One hundred percent of occupied habitat on public lands in the Cuyama Valley, San Juan Creek Valley and Kettleman Hills	Public lands in Cuyama Valley and Kettleman Hills	Stable or increasing populations for the Carrizo, Panoche, and western Kern Co. metapopulations through one precipitation cycle

TABLE 4. *(continued).* ***Generalized Recovery Criteria for Federally-Listed Plants and Animals.***
Though not explicitly stated, delisting criteria include meeting all of the downlisting criteria. Range-wide population monitoring should be provided for in all management plans. See individual species accounts for discussion of recovery strategy and the introduction to this section for a discussion of the bases of the criteria.

Species	Recovery Step	Secure and protect specified recovery areas from incompatible uses	Management Plan approved and implemented for recovery areas that include survival of the species as an objective	Population monitoring in specified recovery areas shows:
Fresno kangaroo rat	*Downlist to threatened*	One hundred percent of occupied habitat on public or conservation lands at three or more distinct sites, each no less than about 384 hectares (950 acres) of usable habitat	For all inhabited areas identified as important to continued survival	Population densities in 3 or more populations do not fall below 2 kangaroo rats per hectare (1 per acre) and have a mean density of 10 or more per hectare (4 or more/acre) during one precipitation cycle
	Delist	One additional site with about 1,012 hectares (2,500 acres) or more of occupied habitat, with a total of no less than 2,164 hectares (5,350 acres) of occupied habitat	For all protected areas identified as important to continued survival	Protected sites have a mean density of 10 kangaroo rats per hectare (4 per acre) during a complete precipitation cycle
Tipton kangaroo rat	*Downlist to threatened*	Three or more distinct areas with 2,000 hectares (4,940 acres) or more of contiguous, occupied habitat, with 30 percent each or more of the minimum acreage in public or conservation ownership	For all protected areas identified as important to continued survival	Stable or increasing populations through one precipitation cycle
	Delist	A total of 9,000 hectares (22,230 acres) hectares or more of occupied habitat in public or conservation ownership		Protected sites have a mean density of 10 kangaroo rats per hectare (4 per acre) during a complete precipitation cycle
blunt-nosed leopard lizard	*Downlist to threatened*	Five or more areas, each of about 2,428 hectares (5,997 acres) or more of contiguous, occupied habitat, including one each on: Valley floor in Merced or Madera Counties; Valley floor in Tulare or Kern Counties; foothills of the Ciervo-Panoche Natural Area, foothills of western Kern County, and the Carrizo Plain Natural Area	For all protected areas identified as important to continued survival	Each protected area has a mean density of two or more lizards per hectare (one per acre) through one precipitation cycle
	Delist	Three additional areas with about 2,428 hectares (5,997 acres) or more of contiguous, occupied habitat, one on the Valley floor, one along the western Valley edge in Kings or Fresno Counties, and one in Upper Cuyama Valley	For all protected areas identified as important to continued survival	Each protected area has a mean density of two or more lizards per hectare through one precipitation cycle

TABLE 4. *(continued).* ***Generalized Recovery Criteria for Federally-Listed Plants and Animals.*** *Though not explicitly stated, delisting criteria include meeting all of the downlisting criteria. Range-wide population monitoring should be provided for in all management plans. See individual species accounts for discussion of recovery strategy and the introduction to this section for a discussion of the bases of the criteria.*

Species	**Recovery Step**	**Secure and protect specified recovery areas from incompatible uses**	**Management Plan approved and implemented for recovery areas that include survival of the species as an objective**	**Population monitoring in specified recovery areas shows:**
San Joaquin kit fox	***Downlist to threatened***	The three core populations, Carrizo Natural Area, western Kern County, and Ciervo-Panoche Area; three satellite populations	For all protected areas identified as important to continued survival	Stable or increasing populations in the three core areas through one precipitation cycle; population interchange between one or more core populations and the three satellite populations
	Delist	Several additional satellite populations (number dependent on results of research) encompassing as much as possible of the environmental and geographic variation of the historic geographic range	For all protected areas identified as important to continued survival	Stable or increasing populations in the three core areas and three or more of the satellite areas during one precipitation cycle

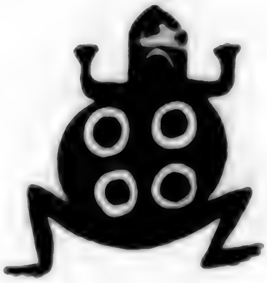

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Table 5. ***Site-Specific Protection Requirements to Meet Delisting Criteria for the Six Federally-Listed Plant and Five Federally-Listed Animal Species.*** *Protection levels apply to any lands specified in the ownership column.*

Species	Site Name	County	Ownership	Protection Level
California jewelflower	Carrizo Plain	San Luis Obispo	USBLM/CDFG/The Nature Conservancy	95 percent of occupied habitat
	Kreyenhagen Hills	Fresno	USBLM	95 percent of occupied habitat
	San Joaquin Valley	any	any	
	1. valley floor			260 hectares (640 acres)
	2. eastern foothills			260 hectares (640 acres)
	Santa Barbara Canyon	Santa Barbara	USBLM/private	90 percent of plants and occupied habitat
Palmate-bracted bird's-beak	Colusa National Wildlife Refuge	Colusa	USFWS	95 percent of occupied habitat
	Delevan National Wildlife Refuge	Colusa	USFWS	95 percent of occupied habitat
	Sacramento National Wildlife Refuge	Colusa/Glenn	USFWS	95 percent of occupied habitat
	San Joaquin Valley			
	1. Alkali Sink Ecological Reserve-Mendota Wildlife Area	Fresno	CDFG	95 percent of occupied habitat
	2. other (including western Madera County)	any	any	260 hectares (640 acres)
	Springtown Alkali Sink	Alameda	CDFG/City of Livermore/ Federal Communications Commission/private	90 percent of plants and occupied habitat
	Central Valley	any	any	2 population, each about 260 hectares (640 acres)
Kern mallow	Lokern	Kern	USBLM/Center for Natural Lands Management/CDFG/ private	90 percent of plants and occupied habitat
	other (if Kern mallow positively identified elsewhere)	Kern	any	2 populations, each about 260 hectares (640 acres)

Table 5 *(continued). Site-Specific Protection Requirements to Meet Delisting Criteria for the Six Federally-Listed Plant and Five Federally-Listed Animal Species. Protection levels apply to any lands specified in the ownership column.*

Species	Site Name	County	Ownership	Protection Level
Hoover's woolly-star	Antelope Plain-Lost Hills-Semitropic	Kern	USBLM/The Nature Conservancy	75 percent of occupied habitat
	Carrizo Plain-Elkhorn Plain-Temblor Range-Caliente Mountains-Cuyama Valley-Sierra Madre Mountains	San Luis Obispo/Santa Barbara	USBLM/CDFG/The Nature Conservancy/U.S. Forest Service	75 percent of occupied habitat
	Kettleman Hills	Fresno/Kings	USBLM	75 percent of occupied habitat
	Lokern-Elk Hills-Buena Vista Hills-Coles Levee-Taft-Maricopa	Kern	USBLM/CDFG/Coles Levee Ecosystem Preserve/U.S. Department of Energy/The Nature Conservancy/Occidental	75 percent of occupied habitat
	San Joaquin Valley floor (may be within above areas including Alkali Sink Ecological Reserve)	any	any	260 hectares (640 acres)
San Joaquin woolly-threads	Carrizo Plain-Elkhorn Plain	San Luis Obispo	USBLM/CDFG/The Nature Conservancy	95 percent of occupied habitat
	Jacalitos Hills	Fresno	USBLM	95 percent of occupied habitat
	Kettleman Hills	Fresno/Kings	USBLM	95 percent of occupied habitat
	Lost Hills	Kern	private	260 hectares (640 acres)
	Panoche Hills	Fresno/San Benito	USBLM	95 percent of occupied habitat
	San Joaquin Valley floor (may be within Lost Hills)	any	any	260 hectares (640 acres)
Bakersfield cactus	Caliente-Bena Hills	Kern	private	90 percent of clumps and occupied habitat
	Comanche Point	Kern	private	90 percent of clumps and occupied habitat
	Cottonwood Creek	Kern	private	90 percent of clumps and occupied habitat
	Fuller Acres	Kern	private	90 percent of clumps and occupied habitat
	Granite Station	Kern	private	90 percent of clumps and occupied habitat

Table 5 *(continued).* ***Site-Specific Protection Requirements to Meet Delisting Criteria for the Six Federally-Listed Plant and Five Federally-Listed Animal Species.*** *Protection levels apply to any lands specified in the ownership column.*

Species	Site Name	County	Ownership	Protection Level
Bakersfield cactus *(continued)*	Kern Bluffs	Kern	private/Kern Co.	90 percent of clumps and occupied habitat
	Kern Canyon	Kern	private	90 percent of clumps and occupied habitat
	Metropolitan Bakersfield south of Kern River	Kern	private	100 clumps
	north of Kern River	Kern	private	100 clumps
	Sand Ridge	Kern	The Nature Conservancy/private	90 percent of clumps and occupied habitat
	Wheeler Ridge	Kern	private/California Department of Water Resources	90 percent of clumps and occupied habitat
Giant kangaroo rat	Ciervo-Panoche Natural Area	Fresno, San Benito	USBLM/CDFG/Private	entire metapopulation
	Western Kern County	Kern	USBLM/CDFG/ California Department of Water Resources/ U.S. Department of Energy/The Nature Conservancy/private	
	1. Lokern Area			90 percent of extant historical habitat
	2. Occidental of Elk Hills			90 percent of extant historical habitat (all in Buena Vista/McKittrick Valleys)
	3. Naval Petroleum Reserve-2			80 percent of extant historical habitat (all in Buena Vista Valley)
	4. Other areas with natural land			80 percent of extant historical habitat
	Carrizo Plain Natural Area	San Luis Obispo/ Santa Barbara	USBLM/CDFG/The Nature Conservancy	entire metapopulation
	San Juan Creek Valley			
	Upper Cuyama Valley			
	Kettleman Hills	Fresno/Kings	USBLM	
Fresno kangaroo rat	Western Madera County	Madera	private	greater than or equal to 1,012 hectares (2,500 acres) of occupied habitat
	Kerman & Alkali Sink Ecological Reserves	Fresno	CDFG	greater than or equal to 384 hectares (950 acres) each of occupied habitat
	Lemoore Naval Air Station	Kings, Fresno	Department of Defense (U.S. Navy)	greater than or equal to 384 hectares (950 acres) of occupied habitat

Table 5 *(continued). **Site-Specific Protection Requirements to Meet Delisting Criteria for the Six Federally-Listed Plant and Five Federally-Listed Animal Species.** Protection levels apply to any lands specified in the ownership column.*

Species	Site Name	County	Ownership	Protection Level
Tipton kangaroo rat	Pixley National Wildlife Refuge-Allensworth Natural Area	Tulare, Kern	USFWS/CDFG/private	greater than or equal to 2,000 hectares (4,942 acres) of contiguous, occupied habitat
	Semitropic Ridge Natural Area	Kern	USFWS/CDFG/The Nature Conservancy/private	greater than or equal to 2,000 hectares (4,942 acres) of contiguous, occupied habitat
	Kern Fan	Kern	Kern County Water Agency	greater than or equal to 2,000 hectares (4,942 acres) of contiguous, occupied habitat
Blunt-nosed leopard lizard	northern Valley floor	Merced or Madera	private	greater than or equal to 2,428 hectares (6,000 acres) contiguous, occupied habitat
	western edge of Valley	Fresno, San Benito	USBLM/private	greater than or equal to 2,428 hectares (6,000 acres) contiguous, occupied habitat
	southern Valley floor	Tulare	USFWS/CDFG/private	greater than or equal to 2,428 hectares (6,000 acres) contiguous, occupied habitat
	west-central edge of Valley	Kings, Fresno	USBLM/private	greater than or equal to 2,428 hectares (6,000 acres) contiguous, occupied habitat
	southern Valley floor	Kern	USFWS/CDFG/The Nature Conservancy/California Department of Water Resources/private	greater than or equal to 2,428 hectares (6,000 acres) contiguous, occupied habitat
	western Kern County	Kern	USBLM/CDFG/Kern County Water Agency/California Department of Water Resources/Department of Energy/Center for Natural Lands Management/private	greater than or equal to 2,428 hectares (6,000 acres) contiguous, occupied habitat
	Carrizo Plain Natural Area	San Luis Obispo	USBLM/CDFG/The Nature Conservancy	entire metapopulation
	Upper Cuyama Valley	San Luis Obispo/Santa Barbara	USFS/USBLM/private	entire metapopulation

Table 5 *(continued). **Site-Specific Protection Requirements to Meet Delisting Criteria for the Six Federally-Listed Plant and Five Federally-Listed Animal Species.** Protection levels apply to any lands specified in the ownership column.*

Species	Site Name	County	Ownership	Protection Level
San Joaquin kit fox[1]	Ciervo-Panoche Natural Area	Fresno, San Benito	USBLM/CDFG/private	90 percent of existing potential habitat
	western Kern County	Kern	USBLM/CDFG/Kern County Water Agency/ California Department of Water Resources/U.S. Department of Energy/ Center for Natural Lands Management/ private	
	Carrizo Plain Natural Area	San Luis Obispo	USBLM/CDFG/The Nature Conservancy/ private	100 percent of existing potential habitat
	greater than or equal to 9 satellite populations:			80 percent of existing potential habitat
	northern range and Valley edges	Alameda, Contra Costa, San Joaquin, Stanislaus	various public and private	
	northern Valley floor	Merced, Madera		
	central Valley floor	Fresno		
	west-central Valley edge	Fresno, Kings		
	southeast Valley floor	Tulare, Kern		
	Kettleman Hills	Fresno, Kings, Kern		
	southwestern Valley floor	Kern		
	Salinas-Pajaro Rivers watershed	Monterey, Santa Benito, San Luis Obispo		
	upper Cuyama Valley	Santa Barbara, San Luis Obispo		

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[1] protection level: extinction probability of 5 percent for 300 years for entire population of the San Joaquin kit fox.

TABLE 6. ***Generalized Criteria for Long-Term Conservation of California-Listed and Federal Candidate Species and Species of Concern.*** *Range-wide population monitoring should be provided for in all management plans. See individual species accounts for discussion of conservation strategy and the introduction to this section for a discussion of the bases of the criteria.*

Species	Secure and protect specified recovery areas from incompatible uses	Management Plan approved and implemented for recovery areas that include survival of the species as an objective	Population monitoring in specified recovery areas shows:
Lesser saltscale	Ninety-five percent of occupied habitat on public lands; five or more populations, including one or more each in Butte and Kern Counties, and one in Fresno, Madera, or Merced County	For all protected areas	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Bakersfield smallscale	Five or more disjunct populations	For all protected areas	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Lost Hills saltbush	Ninety-five percent of occupied habitat on public lands; five or more populations, including at least one each in Fresno, Kern, and San Luis Obispo Counties	For all protected areas	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Vasek's clarkia	Five distinct populations occurring in at least three separate canyons	For all protected areas	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Temblor buckwheat	Ninety-five percent of occupied habitat on public lands; five or more populations, including one each in Kern, Monterey, and San Luis Obispo Counties	For all protected populations	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Tejon poppy	Ninety-five percent of occupied habitat on public lands; five or more populations, including one each on the east, south, and west edges of the southern San Joaquin Valley	For all protected sites	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Diamond-petaled California poppy	Five or more populations, including one each in the northern, central, and southern portions of the historical geographical range	For all protected sites	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle

Table 6. *(continued).* ***Generalized Criteria for Long-Term Conservation of California-Listed and Federal Candidate Species and Species of Concern.*** *Range-wide population monitoring should be provided for in all management plans. See individual species accounts for discussion of conservation strategy and the introduction to this section for a discussion of the bases of the criteria.*

Species	Secure and protect specified recovery areas from incompatible uses	Management Plan approved and implemented for recovery areas that include survival of the species as an objective	Population monitoring in specified recovery areas shows:
Comanche Point Layia	Five or more populations, including one each in the Bena Hills, Comanche-Tejon Hills, and on the San Joaquin Valley floor	For all protected sites	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Munz's tidy-tips	Ninety-five percent of occupied habitat on public lands; five or more populations, including one each in Fresno, Kern, and San Luis Obispo Counties and on the southern San Joaquin Valley floor in Kern County	For all protected sites	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Jared's peppergrass	Ninety-five percent of occupied habitat on public lands; five or more populations of each of the two subspecies, including at least one population of the Carrizo peppergrass subspecies outside of the Carrizo Plain Natural Area	For all protected sites	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Merced monardella	Five or more populations	For all protected populations	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle
Merced phacelia	Five or more populations	For all protected populations	One thousand or more individuals in favorable years; all protected populations are stable or increasing through one precipitation cycle
Oil neststraw	Ninety-five percent of occupied habitat on public lands; five or more populations, including at least one in Kern County outside of the Elk Hills	For all protected populations	One thousand or more individuals in years favorable for growth; all protected populations are stable or increasing through one precipitation cycle

Table 6. *(continued). **Generalized Criteria for Long-Term Conservation of California-Listed and Federal Candidate Species and Species of Concern.** Range-wide population monitoring should be provided for in all management plans. See individual species accounts for discussion of conservation strategy and the introduction to this section for a discussion of the bases of the criteria.*

Species	Secure and protect specified recovery areas from incompatible uses	Management Plan approved and implemented for recovery areas that include survival of the species as an objective	Population monitoring in specified recovery areas shows:
Dune insects (Ciervo aegialian scarab beetle, Doyen's dune weevil, San Joaquin dune beetle)	Five occupied sites for each species (either as co-occupied or allopatric sites) collectively providing 150 hectares (370 acres) of inhabited sands and sand dunes, with the smallest inhabited site providing no less than 0.2 hectare (0.5 acre) of sand habitat, three of the sites must be fully protected from development	For all protected populations	Continuing presence at each occupied site
San Joaquin antelope squirrel	Carrizo Plain Natural Area, Lokern-Elk Hills, and Ciervo-Panoche Natural Area each have a minimum of about 6,070 hectares (15,000 acres) of occupied habitat; and Pixley National Wildlife Refuge-Allensworth-Semitropic Ridge Natural Areas each have of minimum of about 2,400 hectares (5,930 acres) of occupied habitat	For all populations on public and conservation lands	Stable or increasing populations through one precipitation cycle
Short-nosed kangaroo rat	Carrizo Plain Natural Area, western Kern County, and Ciervo-Panoche Natural Area, each with 2,000 hectares (4,940 acres) or more of occupied habitat; South Grasslands population	For all populations on public and conservation lands	Mean population density of six or more kangaroo rats per hectare during average years in precipitation cycle
Riparian woodrat	Three or more areas of occupied habitat each supporting 400 or more individuals, with a total population of 5,000 or more independent individuals (i.e., excluding dependent young) during average precipitation years	For all populations	Mean size of independent population no less than 400 individuals in each population in average years through 1 precipitation cycle
Tulare grasshopper mouse	Those areas specified as the habitat protection goals for the giant kangaroo rat and blunt-nosed leopard lizard	For all protected areas	Continuing presence on the Carrizo Plain Naturel Area, Lokern-Elk Hills area, Ciervo-Panoche Natural Area, and two blocks on the Valley floor

Table 6. *(continued). **Generalized Criteria for Long-Term Conservation of California-Listed and Federal Candidate Species and Species of Concern.** Range-wide population monitoring should be provided for in all management plans. See individual species accounts for discussion of conservation strategy and the introduction to this section for a discussion of the bases of the criteria.*

Species	**Secure and protect specified recovery areas from incompatible uses**	**Management Plan approved and implemented for recovery areas that include survival of the species as an objective**	**Population monitoring in specified recovery areas shows:**
Buena Vista Lake shrew	Three or more disjunct occupied sites collectively with at least 2,000 hectares (4,940 acres) of occupied habitat	For all protected areas	Continuing presence at known occupied sites
Riparian brush rabbit	Three or more sites, each with no less than 300 adults during average years	For all protected sites	Populations sizes of 300 or more adults during average years during a precipitation cycle at each of 3 or more sites
San Joaquin Le Conte's thrasher	Saltbush communities on public lands, including Naval Petroleum Reserve in California-2, Occidental of Elk Hills, the Lokern Natural Area, and the Carrizo Plain Natural Area; and in southwestern Kern County	For all public lands and the inhabited areas covered in the Kern County Valley Floor Habitat Conservation Plan	Stable or increasing through one precipitation cycle

The strategy for plant species of concern is based on the assumption that if populations remain throughout the historical range, are secure from threats, and are not declining, formal listing may not be necessary.

Listed Animal Species.—For listed animal species, downlisting criteria are based on the assumption that extinction is not imminent if potentially viable metapopulations are found at three or more sites representing different geographic and environmental variations. In the absence of specific information to the contrary, metapopulations are assumed to be potentially viable if there is enough continuous, occupied habitat to sustain 5,000 or more adults during average years in a period when annual rainfall cycles from average or above-average through below-average levels and back to at least average. Criteria for individual species are altered from this basic model by: the amounts of potential or actual habitat in existence; information on population dynamics (e.g., San Joaquin kangaroo rat populations fluctuate so dramatically that larger average population sizes are required); information on species densities in various habitats; and extent of historical and current geographic distribution. To the maximum extent possible, recovery areas have been centered on or confined to lands in public or conservation ownership. Where this is not possible, existing natural lands (most with limited development potential) first have been targeted for protection.

Candidate Animal Species and Species of Concern.—Existing information for the riparian brush rabbit, riparian woodrat, and Buena Vista Lake shrew is ample to support a proposal to list them under the Act. Even for these three species, where existing information is sufficient to support listing as threatened or endangered, additional information on distribution and habitat is needed to develop a complete conservation and protection strategy and establish quantitative criteria for their restoration or long-term conservation. Thus, the actions necessary for these candidate species and other species of concern include surveys in suitable habitat and, for some, evaluation of threats. Management actions to counter known threats are recommended in individual accounts. The protection strategies for most candidate animals and species of concern are based on the assumption that if populations remain throughout remnants of the historical range, are secure from threats, and are not declining, formal listing may not be necessary.

C. RECOVERY PRIORITIES

1. General Ranking Categories

Actions necessary to recover a species are ranked in three categories:

> **Priority 1**—an action that must be taken to prevent extinction or to prevent a species from declining irreversibly in the foreseeable future.
>
> **Priority 2**—an action that must be taken to prevent a significant decline in species population or habitat quality or some other significant negative impact short of extinction.
>
> **Priority 3**—all other actions necessary to meet recovery objectives.

In assigning priorities to protection of natural areas and establishment of reserves, each site was evaluated in the context of all other sites supporting the species, and the priority assigned based on the impact the development of that site alone would have on the species chances of recovery. For some of the larger sites, the entire area may not warrant the priority ranking of some subset of sites that are important to fewer species and for which a speciality reserve may be needed. Yet, in the absence of more information, the entire area was assigned the highest priority. In making management and administrative decisions, each site's importance must be considered in the context of what has and is likely to happen to all other sites, but those events cannot be forecast now.

2. Priority Ranking Emphasis

The ecosystem-level strategy outlined in the beginning of this chapter focuses on establishing a network of reserves and conservation areas by protecting natural communities, strategically retiring farmland and using a focused safe harbor program on private lands. In this document, *habitat protection* means ensuring appropriate uses of land to maintain and enhance species habitat values. Habitat protection does not necessarily require land acquisition or easement. There are many other ways to achieve the same end while keeping land in private ownership and fostering continuing, traditional uses that contribute to the local and national economies (Keystone Center 1995).

To ensure appropriate uses of conservation and mitigation land to maintain and enhance species habitat values requires, in most cases, active management of the land. To this date, land acquired in the Valley as mitigation for project-related habitat losses, and some parcels acquired from conservation funds, are mostly not being actively managed to maintain or enhance listed species populations. Therefore, if San Joaquin Valley species are to be recovered, more emphasis must be placed on habitat management. There already are substantial historical habitats for a majority of species featured in this plan in public ownership, though they mostly are not sufficiently protected from catastrophes, such as flooding and excessive soil erosion, nor appropriately monitored and managed to maintain or enhance populations of featured species. Developing necessary habitat management procedures must not be neglected in favor of acquisition of additional potential habitat.

There are reasons to place increased emphasis on habitat management research:

a. Change in ownership from private to public usually is accompanied by a change in land use. For natural lands, the principal use typically is ranching. Cessation of grazing upon purchase has frequently been followed by decline of listed species populations (though the magnitude is difficult to demonstrate on many parcels because no baseline population censuses were conducted before change in land use, and no quantitative monitoring programs were established). Grazing and other uses of land that affect the structure and composition of the community may be important habitat elements for the object species—until proven otherwise it is prudent to assume that if the species are resident, the existing land uses (at some level) do not pose an immediate threat to species survival (Williams and Germano 1993).

b. Many parcels acquired as mitigation are too small and scattered to manage effectively. They remain idle until critical masses of land and management funds can accumulate. Meanwhile, habitat quality and species populations decline or disappear, instead of increase.

c. When dealing with several listed species affected by a permitted project, some may have conflicting habitat management needs—managing for one species or a *guild* (a group of species with a common need for a particular habitat or other niche component) may negatively affect another species or guild (Williams and Germano 1993). More and better data are needed for developing a protection strategy that ensures that all sensitive species will benefit from selected management actions.

For some species, their statuses have deteriorated to a point where the only way they can be saved is by immediate implementation of programs that employ adaptive management (conduct important biological research, monitor and evaluate outcomes; readjust management direction accordingly). For many of the other species, the risk is great that if information needs are not attended to soon, their statuses will be similarly jeopardized. Habitat management has high priority for half of the 34 species, though at least 11 of the other 17 also have habitat management research as a high priority, indicating that information is insufficient to develop appropriate management prescriptions today.

IV. STEPDOWN NARRATIVE

1 Develop and implement a regional cooperative program and participation plan.

Development of a regional cooperative program coordinating local public and private land use planning with State and Federal land use planning, recovery planning, and biodiversity conservation is needed. From this program, a participation plan should be developed and implemented to expedite and increase the chances of recovery for listed species and ensure long-term conservation of the 23 other species covered in this recovery plan.

1.1 Establish a regional cooperative program with participants from the public and private sector (Priority 2).

Successful development of a regional cooperative program and preparation of a participation plan requires involvement by public and private interests in the planning area. Interested parties at all levels of government and in the private sector should be identified and their willingness to participate in a cooperative program determined. Once participants are identified, the program should be initiated.

1.2 Develop and implement participation plans.

Participation plans should be developed to implement recovery. These plans should include outreach efforts to enhance the public's understanding of endangered species issues, economic incentives for conservation of endangered species on private lands, guidance on mitigation banking and establishment of large-scale Habitat Conservation Plans, focused safe harbor programs, and focused retirement of drainage problem lands. Separate participation plans may be developed and implemented for many of the tasks contained herein.

1.2.1 Develop and implement an outreach plan (Priority 2).

Outreach is an important component of implementing this recovery plan. A plan should be developed by the regional cooperative program to provide factual information about featured species and the recovery process to interested and affected landowners. An important focus of outreach should be toward landowners with reported or potential occurrences of featured species. For private lands with reported populations of featured species, landowners should be apprised of the significance of the populations on their lands and should be provided with information about available conservation mechanisms, such as conservation easements and incentive programs (See Task 1.2.2). For private lands with potential occurrences of featured species, permission should be sought from cooperative landowners to conduct on-site surveys. If surveys identify populations of featured species, landowners should be apprised of their significance and offered incentives to continue current land uses that support featured species habitat.

1.2.2 Develop and implement economic or other incentives for conservation and recovery on private lands through the cooperative program and with other groups (Priority 2).

Economic and other incentive programs (relief from taxes, tax credits, tax deductible habitat management expenses, Williamson Act, Conservation Reserve Program, Partners for Wildlife, and others) are important to gaining the support and assistance of private landowners in conserving and recovering species featured in this recovery plan (Hudson 1993, Dwyer et al. 1995, Keystone Center 1995, Eisner et al. 1995). As part of the regional cooperative program, or through working with other groups, such programs should be developed for the planning area. Incentive programs should play a role in protection of habitat on private property (See Task 2.1 and 2.2), and in establishing linkages on the Valley floor (Task 5.1) and elsewhere (Task 5.3).

1.2.3 Encourage and assist counties and owners of large amounts of natural lands in developing and implementing large-area Habitat Conservation Plans (Priority 2).

City and county governments are the primary agencies in deciding on land uses, and thus, their involvement in any future recovery planning processes is critical. Habitat Conservation Plans have been developed and others are being developed. The regional cooperative program should promote similar initiatives in other counties in the planning area. Assistance should also be provided to owners of large amounts of natural land.

1.2.4 Encourage and assist in the development and implementation of *mitigation banks* separately or in conjunction with large-scale Habitat Conservation Plans (Priority 2).

Mitigation banks should be promoted by the regional cooperative program as a means of overcoming many of the problems associated with mitigating for lost habitat on a piecemeal basis, separately or in conjunction with large scale Habitat Conservation Plans. Areas with the greatest potential for mitigation banks are western Kern County (one established, another in planning), the Coalinga and Ciervo-Panoche areas of western Fresno County, western Madera County, and other, lightly-developed oil and gas-producing areas. However, all large blocks of privately-owned natural land that are identified as important in this recovery plan should be considered.

1.2.5 Encourage and assist landowners and private interest groups in developing focused safe-harbor programs (Priority 2).

Farming interests, the CDFG, and USFWS are pursuing the development of generalized safe harbor programs in California. To assist in endangered species recovery, specific programs should be developed by the regional cooperative program or other groups. These programs should be carried out in a controlled, experimental manner for the San Joaquin kit fox, and perhaps other species on both irrigated and non-irrigated ground. Implementation of a focused safe harbor program is one of several programs needed to establish linkages for featured species between islands of natural habitat on the Valley floor (See Task 5.1). Components of a pilot safe harbor program and areas to be targeted for San Joaquin kit fox are outlined in Appendix E.

1.2.6 Coordinate retirement of farmlands with drainage problems with recovery needs of featured species (Priority 2).

Focused retirement of drainage problem lands is an important component of establishing linkages between islands of natural habitat on the Valley floor for San Joaquin kit fox and other featured species (See Task 5.1). The regional cooperative program should guide the implementation of this land retirement program so that priority is given to land retirement in areas needed for endangered species recovery. Criteria for land retirement, restoration of retired farmland, and guidelines for the program are provided in Appendix F.

2 Protect and secure existing populations.

Natural lands known to provide habitat for listed and other sensitive species, should be protected and secured from any identified threats in perpetuity. Protection of these habitat areas requires application of adaptive management (See Task 6) to ensure species survival and recovery. Natural lands needing protection include large blocks of land that function as core areas for listed species, and smaller blocks of land, called 'specialty' reserves that are usually locations of populations of single species.

2.1 Protect and secure core habitat areas.

Table 7 lists all core areas, or large blocks of land requiring protection. Public and conservation lands listed in Table 7 should be adaptively managed to maximize their potential to support listed and sensitive species. Private lands included in Table 7 should be protected through voluntary conservation or management agreements (agreements in which a landowner agrees to manage property in a specified way), easements or other mechanisms, then adaptively managed. Management plans should be developed for all protected areas.

Table 7. *Large Blocks or Core Areas of Natural Lands Targeted for Protection. See Figure 70 for the location of core habitat areas.*

Recovery Task #	Locality	County	Species (target in bold)[1]	Landowner/Comments	Priority
2.1.1	Elk Hills and Buena Vista Valley	Kern	**hws, ons, bnll, gkr, sjkf**, sjwt, tp, **sjas, smkr, tgm, sjlt**	Department of Energy/Occidental/ Chevron/ secure long-term protection of natural communities and featured species; prevent disturbance of ons metapopulation.	1
2.1.2	Fort Hunter Liggett/ Camp Roberts	Monterey, San Luis Obispo	**sjkf**	Department of Defense, California National Guard/ evaluate recent and ongoing base operations and land management studies on kit fox, prepare management plans beneficial to kit fox.	2
2.1.3	Kern Fan Element	Kern	**tkr, sjkf, bnll, bvls,** hws, sjwt, bss, lss, lhsb, gkr, tgm, sjlt	Kern Water Bank Authority/ protect, restore and enhance upland and wetland communities, introduce bvls and other targeted species through cooperative agreement. Also provides a linkage between Lokern/Elk Hills and Tule Elk Reserve/Kern River Parkway.	1
2.1.4	Western Kern County (includes Lokern)	Kern	**km, ons, lhsb, bnll, sjas, gkr, smkr, tgm, sjkf, sjlt, hws, tbw**, jpg, cjf, tp, sjwt	USBLM, Center for Natural Lands Management, private/ preserve 80-90 percent of the existing natural lands below about 500 meters (1,640 feet) between Blackwell's Corner and Maricopa. The Lokern area is within the Kern County Valley Floor Habitat Conservation Plan and a Chevron, USA, Inc. mitigation bank; restore habitat for sjlt; prevent disturbances of ons metapopulation.	1

Recovery Task #	Locality	County	Species (target in bold)[1]	Landowner/Comments	Priority
2.1.5	Western Madera County	Madera	**pbbb, sjkf, bnll, fkr, lss**, lhsb	Private / continue traditional land uses (natural gas extraction and cattle grazing), possible groundwater recharge and water banking site, an important link in the chain of habitat islands on Valley floor. Acquire title or easements for appropriate parcels from willing sellers.	1
2.1.6	North central Fresno County	Fresno	pbbb, **bnll, fkr, sjkf**	Private/ located between the San Joaquin River, immediately north of the Alkali Sink Ecological Reserve, and San Mateo Road on the west, connects Alkali Sink Ecological Reserve to the Chowchilla Canal, an important link in the chain of habitat islands on Valley floor. Acquire title or easements for appropriate parcels from willing sellers.	2
2.1.7	Pixley National Wildlife Refuge/ Allensworth Natural Area	Tulare, Kern	**tkr, bnll, sjkf**	Private, public/ includes the best and only large remnants of Relictual Interior Dune Grassland, variations of chenopod scrub, and Haplopappus Shrubland in the Tulare Basin. Acquire title or easements for appropriate parcels from willing sellers; restore habitat for tkr.	1
2.1.8	Northwestern Merced County	Merced	lhsb, lss, **sjkf**	Public/ includes Federal wildlife refuges and waterfowl easement properties, State game areas, and State park land, provides a vital linkage between Valley floor and northwestern Valley edge; restore and enhance natural communities by practicing adaptive management, control grazing; (riparian areas are listed separately in Table 8).	3
2.1.9	Sandy Mush Road/ South Grasslands Area	Merced	**lhsb, bnll**, sjkf, lss, pbbb, fkr	Private/ a chain of habitat islands on the valley floor, that together with establishing Valley floor linkages through agricultural land, links Merced County National Wildlife Refuges, State areas and other natural lands with the northeastern and northwestern edges of the Valley and with natural areas to the south. Acquire title or easements for appropriate parcels from willing sellers.	2

Recovery Task #	Locality	County	Species (target in bold)[1]	Landowner/Comments	Priority
2.1.10	Kettleman Hills	Fresno, Kings	**sjwt**, **bnll**, **gkr**, **sjas**, **sjkf**, **snkr**, **tgm**, ddw, **hws**, **sjdb**, sjlt	USBLM, private/ protect area from development through acquisition or easements from willing sellers; conduct land survey to determine ownership of site with ddw, major population center for sjwt, hws.	1
2.1.11	Kern National Wildlife Refuge/ Semitropic Ridge Natural Area	Kern	**hws**, **bnll**, **sjas**, **sjkf**, tkr, **bvls**, mtt, lhsb, sjwt, **tgm**	USFWS, State, private/ enhance natural communities by creation of areas of refuge above historic flood levels for tkr, provides link for sjkf to Pixley/ Allensworth area, designated as preapproved acquisition area for the Metropolitan Bakersfield Habitat Conservation Plan. Manage and restore appropriate habitat, and introduce bvls. Acquire title or easements for appropriate parcels from willing sellers.	3
2.1.12	Carrizo Plain Natural Area	San Luis Obispo	**cjf**, **hws**, **jpg**, **tbw**, **sjwt**, **bnll**, **gkr**, **sjas**, **sjkf**, **snkr**, **tgm**, **sjlt**, **lhsb**, **mtt**	USBLM, State, The Nature Conservancy, private/ restore and enhance natural communities by practicing adaptive management; reintroduce featured species to suitable habitat where appropriate.	1
2.1.13	Upper Cuyama Valley	Santa Barbara, San Luis Obispo	**cjf**, hws, sjwt, **bnll**, **gkr**, sjas, sjkf, **snkr**, tgm, sjlt	USBLM, private/ protect natural lands from development through acquisition or easement from willing sellers; ensure traditional rangeland uses continue while protecting vulnerable plant populations (Santa Barbara Canyon listed as a speciality reserve area in Table 8).	3
2.1.14	Ciervo-Panoche Natural Area	Fresno, San Benito	**jpg**, **hws**, **sjwt**, lhsb, mtt, **bnll**, **gkr**, **sjas**, **sjkf**, sjlt, snkr, tgm, **cnnb**, **sjdb**	USBLM, State, private/ protect natural lands from development through acquisition or easement from willing sellers; ensure traditional rangeland uses continue while monitoring and protecting vulnerable plant and insect populations.	1
2.1.15	Kreyenhagen Hills	Fresno	**cjf**, sjkf, snkr	USBLM, private/ only known population of cjf on public land east of the inner Coast Ranges; continue protecting cjf population and managing rangeland in an adaptive manner.	1

Recovery Task #	Locality	County	Species (target in bold)[1]	Landowner/Comments	Priority
2.1.16	Bitter Creek National Wildlife Refuge	Kern, Ventura	sjas, sjkf, tgm	USFWS/ restore and enhance natural communities by practicing adaptive management.	3
2.1.17	Kerman and Alkali Sink Ecological Refuges	Fresno	**pbbb**, sjkf, fkr, bnll, hws, lss, lhsb	CDFG/ restore and enhance natural communities by practicing adaptive management; reintroduce fkr.	1
2.1.18	Mendota Wildlife Area	Fresno	**pbbb**, sjkf, fkr, snkr, bnll	CDFG/ manage appropriately for featured species, develop specific management agreement for areas not managed for waterfowl.	3
2.1.19	Northwestern portion of kit fox range	Alameda, Contra Costa	**sjkf**	Mostly private/ maintain larger natural areas identified in CDFG's Framework for Maintaining the San Joaquin Kit Fox in the Northwestern Segment of its Range (in litt. 1996), maintain beneficial grazing practices.	2

[1] Species
bc – Bakersfield cactus; bnll – Blunt-nosed leopard lizard; bss – Bakersfield smallscale; bvls – Buena Vista Lake shrew; casb – Ciervo aegialian scarab beetle; cjf – California jewelflower; cpl – Comanche Point layia; ddw – Doyen's dune weevil; dpcp – Diamond-petaled California poppy; fkr – Fresno kangaroo rat; gkr – Giant kangaroo rat; hws – Hoover's woolly-star; jpg – Jared's peppergrass; km – Kern mallow; lhsb – Lost Hills saltbush; lss – Lesser saltscale; mm – Merced monardella; mp – Merced phacelia; mtt – Munz's tidy-tips; ons – Oil neststraw; pbbb – Palmate-bracted bird's-beak; tp – Tejon poppy; rbr – Riparian brush rabbit; rwr – Riparian woodrat; sjas – San Joaquin antelope squirrel; sjdb – San Joaquin dune beetle; sjkf – San Joaquin kit fox; sjkr – San Joaquin kangaroo rat; sjlt – San Joaquin Le Conte's thrasher; sjwt – San Joaquin woolly-threads; snkr – Short-nosed kangaroo rat; tbw – Temblor buckwheat; tgm – Tulare grasshopper mouse; tkr – Tipton kangaroo rat; vc – Vasek's clarkia

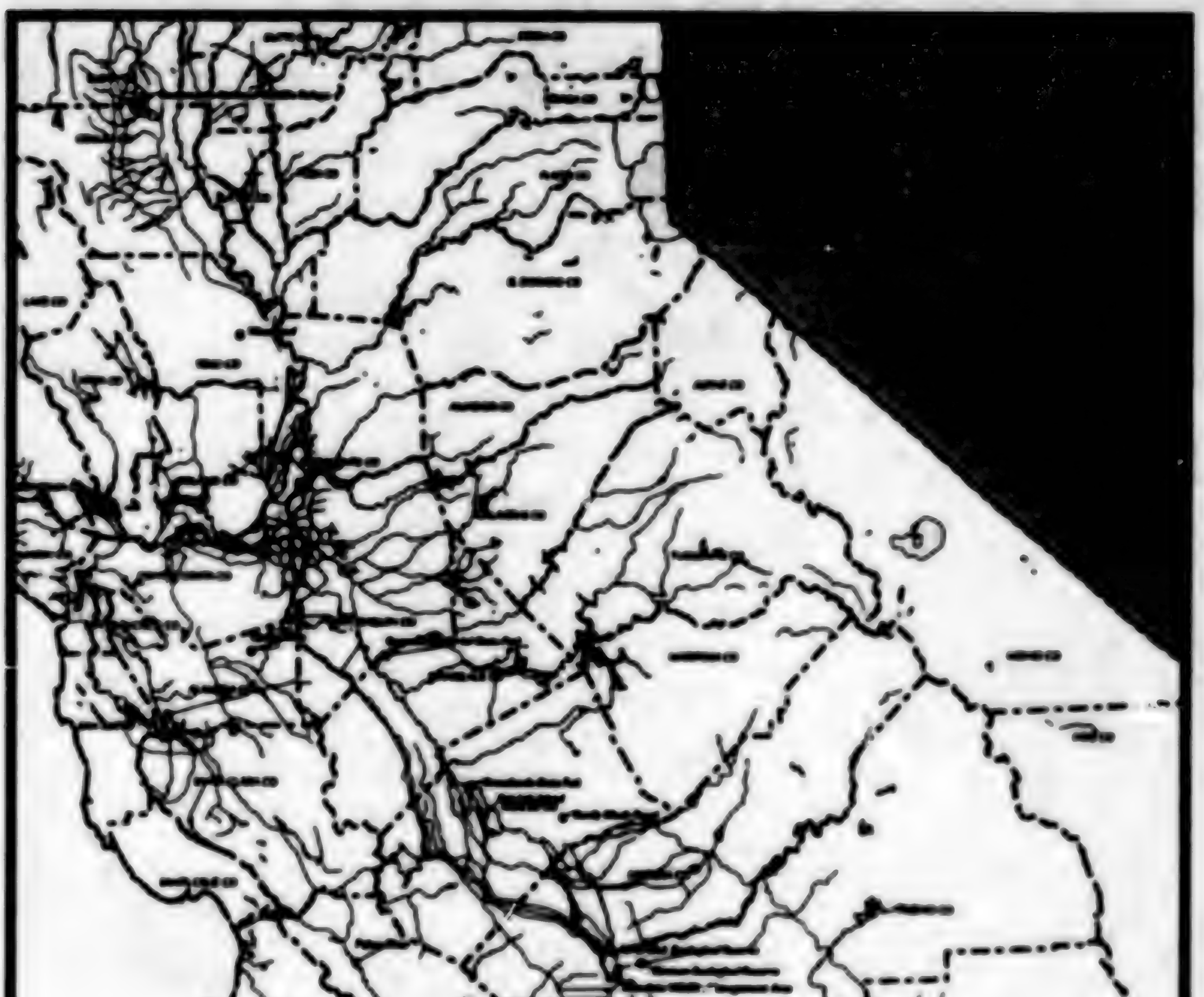


Figure 70. Place locations for Tables 7, 9, and 10.

2.2 Establish and protect specialty reserves.

Table 8 lists specialty reserves to be established. Figure 71 shows the general location of these specialty reserves. Several of these specialty reserves are located within linkage areas (See Task 5). Public and conservation lands listed in Table 8 should be adaptively managed to maximize their potential to support listed and sensitive species. Private lands included in Table 8 should be protected through conservation or management agreements, acquisition, easements or other mechanisms, then adaptively managed. Management plans should be developed for all protected areas.

Table 8. *Natural Lands Targeted for Protection as Specialty Reserves. See Figure 71 for the location of each specialty reserve.*

Recovery Task #	Locality (Map Symbol - Figure 71)	County	Species (target in bold)[1]	Landowner/Comments	Priority
2.2.1	Woodland (A)	Yolo	**pbbb**	City of Woodland/ develop and implement habitat restoration, enhancement and management plan.	1
2.2.2	Springtown Alkali Sink (B)	Alameda	**pbbb**	CDFG, City of Livermore, Federal Communications Commission, private/ enhance habitat. develop and implement a plan to restore natural hydrology, establish cooperative management program; greatest genetic diversity for pbbb.	1
2.2.3	Lower Stanislaus River (C)	San Joaquin, Stanislaus	**rbr, rwr**	COE/ review and enforce wildlife habitat easements downstream from the City of Ripon, restore riparian habitat, provide additional flood and fire protection; prepare emergency preplan for habitat protection at Caswell State Park; reintroduce rbr, rwr.	1
2.2.4	San Joaquin River National Wildlife Refuge (D)	Stanislaus	**rbr, rwr**	USFWS-Private/ restore riparian habitat, provide additional flood and fire protection; reintroduce rbr, rwr.	1
2.2.5	San Joaquin River Riparian Communities (E)	Merced	**rbr, rwr**, sjkf	CDFG, California Department of Parks and Recreation, USFWS/ restore riparian habitat, manage grazing, provide additional flood and fire protection, upland habitat may provide linkage; reintroduce rbr, rwr.	1
2.2.6	Lemoore Naval Air Station (F)	Kings	**fkr**, bnll, sjkf	Navy/ enlarge and restore habitat area by retiring adjacent farmland on the base.	1

Recovery Task #	Locality (Map Symbol - Figure 71)	County	Species (target in bold)*	Landowner/Comments	Priority
2.2.7	North of Tulare Lake Bed (G)	Kings	fkr, bnll, sjkf	Private/ preserve as grazing land; possible mitigation bank sites.	1
2.2.8	Granite Station (H)	Kern	bc	Private/ isolated from metropolitan Bakersfield population, potential contribution to taxonomic information, maintain current land uses.	2
2.2.9	Devil's Den Area (I)	Kern	**bws, jpg**, cjf, tbw, bnll, sjkf, snkr, sjas, sjlt, sgm	Private, USBLM/ maintain compatible land uses	2
2.2.10	Lost Hills-Buena Vista Slough (J)	Kern	**sjwt, llnb**, mtt, bws, **sjkf**, snkr, bnll, tkr, sjas	Private/ also provides an important link between natural lands along the western edge of the Valley and natural lands in the Semitropic and Pixley-Allensworth areas; one of largest metapopulations of sjwt.	2
2.2.11	Jerry Slough to Highway 58 (K)	Kern	ls, bws	Private/ southeast of Goose Lake bed; southernmost population of ls, maintain current land uses.	2
2.2.12	Greater Bakersfield, North of the Kern River (L)	Kern	bc, bnll, sjkf	Private, CDFG/ maintain existing land uses of oil production and grazing, avoid or fence plant populations.	2
2.2.13	Fairfax Road-Highway 178-Highway 184 (M)	Kern	bc	Private/ type locality for var. *kernii*, fence fragmented populations.	2
2.2.14	Kern Bluffs (N)	Kern	bc, sjkf, bnll, snkr	Private, CDFG/ fence to exclude off-road vehicles from the wash area; monitor vegetation to determine effects of changing the grazing regime.	1
2.2.15	Fuller Acres (O)	Kern	bc	Private/ lowest elevation remaining occurrence of bc, last remnant of once extensive population.	2

Recovery Task #	Locality (Map Symbol - Figure 71)	County	Species (target in bold)¹	Landowner/Comments	Priority
2.2.16	Mouth of Kern Canyon (P)	Kern	bc	Private/ population contains considerable morphological variation, maintain current land uses.	2
2.2.17	Cottonwood Creek (Q)	Kern	bc	Private, CDFG/ only site in association with cottonwoods, one of few sites with typical var. *treleasei*, maintain current land uses.	2
2.2.18	Bena Hills-Caliente Hills (R)	Kern	vc, bc, cjf, cpl, tp	Private/ delimited in north by Walker Basin, south by Highway 58, southeast by Caliente, and west by Valley floor, type locality of bc, only known location of vc, maintain current land uses.	1
2.2.19	Sand Ridge (S)	Kern	bc, sjwt, sjkf, snkr	Center for Natural Lands Management, CDFG, private/ one of two largest metapopulations of bc, expand reserve, protect natural lands from off-road vehicles, sand mining, and conversion.	1
2.2.20	Comanche-Tejon Hills (T)	Kern	cpl, tp, bc, sjkf, bnll, snkr	Private/ maintain current land uses.	1
2.2.21	Kern Lake-Gator Pond (U)	Kern	bvls, bss, cpl	Private/ only known population of bvls and bss, restore hydrology and wetland vegetation; protect and secure permanent water supply.	1
2.2.22	Mettler-Wheeler Ridge (V)	Kern	bc, bnll, snkr, sjkf	Private, California Department of Water Resources, Wildlands Conservancy/ one of largest metapopulations of bc.	1
2.2.23	Upper Cuyama Valley, Santa Barbara Canyon (W)	Santa Barbara	cjf, hwa, sjwt, bnll, gkr, sjas, sjkf, snkr, tgm	USBLM, private/ largest extant population of cjf.	1
2.2.24	Interstate 5/ California Highway 41 (X)	Kings	ddw	Caltrans/ protect habitat on Caltrans right-of-way.	1

Recovery Task #	Locality (Map Symbol - Figure 71)	County	Species (target in bold)[1]	Landowner/Comments	Priority
2.2.25	Colusa, Delevan, and Sacramento National Wildlife Refuges (Y)	Colusa, Glenn	pbbb, lss	USFWS/ develop and implement management plans; largest population of pbbb.	1
2.2.26	Lawrence Livermore Laboratory/ Site 300 (Z)	Alameda	dpcp	Department of Energy/ develop and implement a management plan for dpcp.	1

[1] Species
bc – Bakersfield cactus; bnll – Blunt-nosed leopard lizard; bss – Bakersfield smallscale; bvls – Buena Vista Lake shrew; casb – Ciervo aegialian scarab beetle; cjf – California jewelflower; cpl – Comanche Point layia; ddw – Doyen's dune weevil; dpcp – Diamond-petaled California poppy; fkr – Fresno kangaroo rat; gkr – Giant kangaroo rat; hws – Hoover's woolly-star; jpg – Jared's peppergrass; km – Kern mallow; lhsb – Lost Hills saltbush; lss – Lesser saltscale; mm – Merced monardella; mp – Merced phacelia; mtt – Munz's tidy-tips; ons – Oil neststraw; pbbb – Palmate-bracted bird's-beak; tp – Tejon poppy; rbr – Riparian brush rabbit; rwr – Riparian woodrat; sjas – San Joaquin antelope squirrel; sjdb – San Joaquin dune beetle; sjkf – San Joaquin kit fox; sjkr – San Joaquin kangaroo rat; sjlt – San Joaquin Le Conte's thrasher; sjwt – San Joaquin woolly-threads; snkr – Short-nosed kangaroo rat; tbw – Temblor buckwheat; tgm – Tulare grasshopper mouse; tkr – Tipton kangaroo rat; vc – Vasek's clarkia

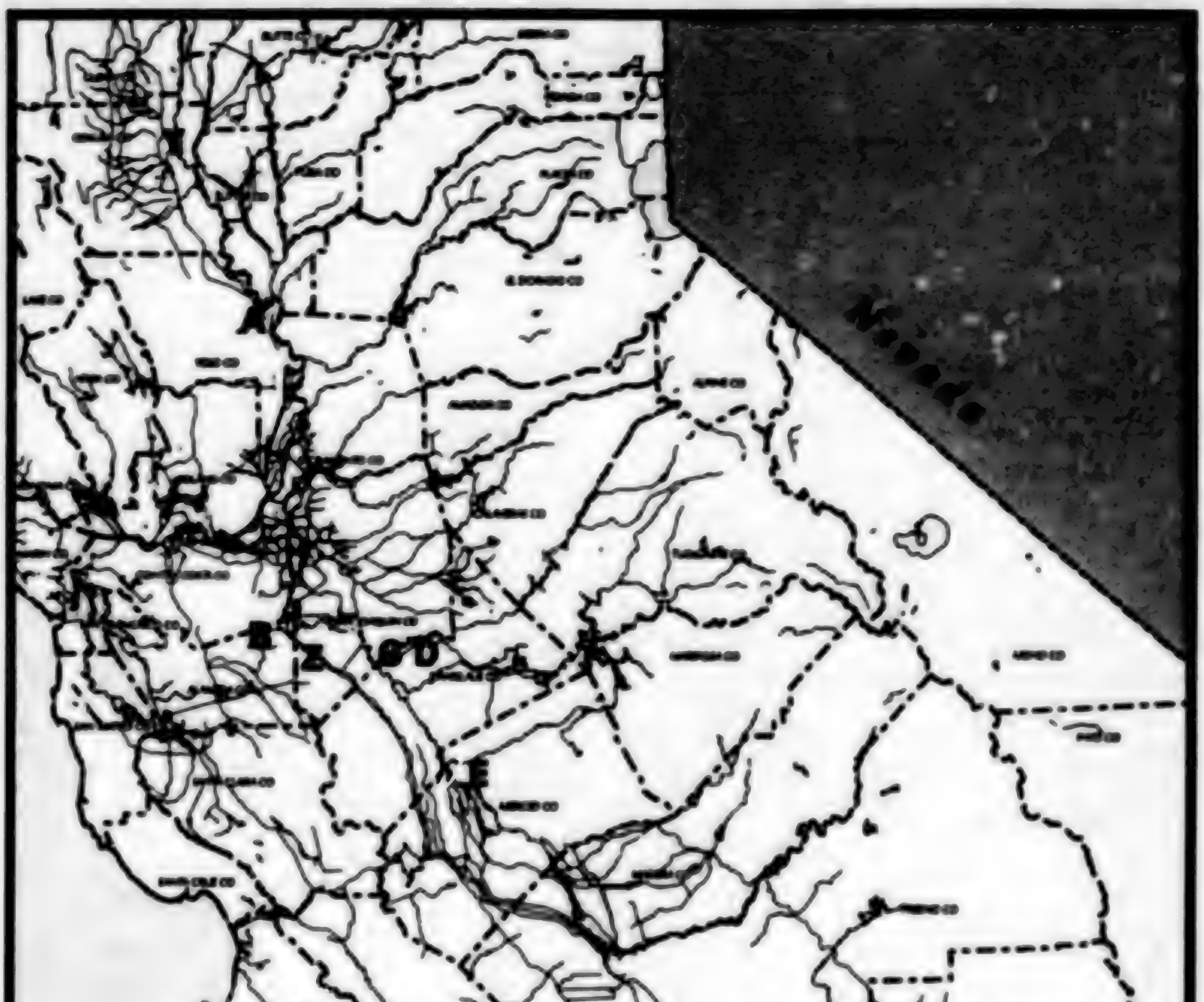


Figure 71. Locations of specialty reserves targeted for protection (see Table 8).

3 Determine distributions and population statuses of featured species.

Data on distribution and population numbers of most featured species are insufficient for development of management prescriptions and to implement other conservation measures. Surveys are a high priority for 22 of the 34 species and are an important priority for 9 others in this plan. Integrated programs (e.g., surveying an area for multiple species when possible) should be developed and implemented to increase efficiency and reduce costs.

3.1 Establish a program and protocol for general and directed surveys for covered species (Priority 1).

A coordinated program should be developed to effectively conduct surveys for featured species. A protocol should be established for directed botanical surveys (i.e., for species whose flowering or season of growth differs from the majority of plants) and general surveys for plants and animals.

3.2 Conduct general and directed surveys as needed.

Table 9 summarizes survey and population census needs for featured species. Directed and general botanical surveys are needed on remaining natural lands throughout the planning area, but especially along the eastern and southern edges of the Valley foothills. For featured animal species, information on occurrence and status is minimal along the eastern and southern edges of the Valley, in the Merced grasslands, and in the Salinas River and Pajaro River watersheds. Obtaining reliable distributional and population data for the San Joaquin kit fox is a high priority.

Table 9. ***Survey and Population Census Needs for Featured Species by Geographic Area or Community in the San Joaquin Valley Planning Area.*** *See Figure 70 for the location of specific survey areas.*

Task Number	Area	Target Species [1] (additional featured species known or possible)	Comments	Priority
Multispecies Plant Surveys				
3.2.1	Comanche-Tejon Hills	tp, cpl (bc)	Kern Co.	1
3.2.2	Caliente-Bena Hills	cjf, vc, tp, cpl (bc)	Kern Co.	1
3.2.3	Rancheria Gulch/Adobe Canyon	cjf, vc, tp, cpl (bc)	Kern Co.	2
3.2.4	southern Valley alkali sinks	lss, bss, & lhsb	Kern Co., summer-fall	1
		cpl, mtt	Kern Co., spring	2
3.2.5	alkali sinks in San Joaquin Valley north of Kern County	pbbb, lss, lhsb	Tulare, Kings, Fresno, Madera, Merced, Stanislaus, San Joaquin, Alameda, and Contra Costa Counties [summer-fall]	1
		mtt, jpg	Tulare, Kings, Fresno, Madera, and Merced Counties [spring]	2
3.2.6	alkali sinks in Sacramento Valley	pbbb, lss	Sacramento, Solano, Yolo, Sutter, Colusa, Butte, and Glenn Counties	2

Task Number	Area	Target Species ¹ (additional featured species known or possible)	Comments	Priority
3.2.7	Occidental of Elk Hills	lhsb, tp, ons (cjf, km, hws, sjwt, tbw)	Kern Co.	1
3.2.8	west side of southern San Joaquin Valley (Maricopa to McKittrick, including Buena Vista Valley and Naval Petroleum Reserve in California-2)	cjf, km, lhsb, tp, ons (hws, sjwt, tbw)	Kern Co.	1
Single Species Plant Surveys				
3.2.9	Cottonwood Pass	cjf	Kern and Kings Counties	2
3.2.10	historic locations outside of Elk Hills	tbw	Kern, San Luis Obispo, and Monterey Counties	2
3.2.11	Salt Creek	tp	Kern Co.	2
3.2.12	historic locations	dpcp	San Luis Obispo, Stanislaus, Alameda, Contra Costa, and Colusa Counties	1
3.2.13	historic locations in San Luis Obispo County	mtt	San Luis Obispo Co.	2
3.2.14	historic locations	jpg	San Luis Obispo, Fresno, and San Benito Counties	2
3.2.15	suitable habitat in historic range	mm	Merced and Stanislaus Counties	1
3.2.16	historic locations	mp	Merced Co.	2
Multispecies Animal Surveys				
3.2.17	sand and sand dune communities, northwestern San Joaquin Valley	casb, sjdb, ddw	Contra Costa, San Joaquin, Stanislaus, Merced, Fresno, San Benito Counties	3
3.2.18	upland vertebrates, northern Valley floor	bnll, fkr, sjkf (pbbb, lss, lhsb)	central Merced, W. Madera, central Fresno Counties; summer to early fall	1
3.2.19	upland vertebrates, southern Valley floor	bnll, tkr, fkr, sjkf, sjlt, tgm (lss, bss, lhsb)	Kings, Tulare, Kern Counties; summer to early fall	3
3.2.20	upland vertebrates, central western Valley edge	bnll, gkr, snkr, sjas, sjkr, sjlt, tgm	Fresno, San Benito Counties; late spring to early fall	3
3.2.21	upland vertebrates, Kettleman Hills	bnll, gkr, snkr, sjas sjkr, sjlt, tgm	Fresno, Kings, Kern Counties; late spring to early fall	2

Task Number	Area	Target Species[1] (additional featured species known or possible)	Comments	Priority
3.2.22	upland vertebrates, southwestern Valley edge	bnll, gkr, snkr, sjas sjkr, sjlt, tgm	Kings, Kern Counties from south of Pleasant Valley to south of Maricopa; late spring to early fall	3
3.2.23	upland vertebrates, southeast and southern Valley edge	bnll, snkr, sjas, sjkr, sjlt, tgm	Kern Co. from Maricopa southward and eastward, then northward to the Kern River; late spring to early fall	3
3.2.24	upland vertebrates, Cuyama Valley	bnll, gkr, snkr, sjas sjkr, sjlt, tgm	Ventura, Santa Barbara, San Luis Obispo Counties; late spring to early fall	3
3.2.25	upland vertebrates, San Juan Creek watershed	bnll, gkr, snkr, sjas sjkr, sjlt, tgm	San Luis Obispo Co.; late spring to early fall	3
3.2.26	riparian species	rbr, rwr	San Joaquin, Stanislaus Counties	1
Single Species Animal Surveys				
3.2.27	northwestern portion of range and northwestern Valley edge	sjkf	Contra Costa, Alameda, San Joaquin, Stanislaus Counties	3
3.2.28	northeastern Valley edge	sjkf	Stanislaus, Merced, Madera Counties	3
3.2.29	Ciervo-Panoche Natural Area	sjlt	Fresno, San Benito Counties	3
3.2.30	southern Valley wetlands	bvls (lss, bss, llsb)	Kern, Tulare Counties	1
3.2.31	southeastern Valley edge	sjkf	Tulare, Kern Counties, north of Kern River	3
3.2.32	Salinas River and Pajaro River watersheds	sjkf	San Luis Obispo, Monterey, San Benito Counties	2

[1] Species

bc – Bakersfield cactus; bnll – Blunt-nosed leopard lizard; bss – Bakersfield smallscale; bvls – Buena Vista Lake shrew; casb – Ciervo aegialian scarab beetle; cjf – California jewelflower; cpl – Comanche Point layia; ddw – Doyen's dune weevil; dpcp – Diamond-petaled California poppy; fkr – Fresno kangaroo rat; gkr – Giant kangaroo rat; hws – Hoover's woolly-star; jpg – Jared's peppergrass; km – Kern mallow; llsb – Lost Hills saltbush; lss – Lesser saltscale; mm – Merced monardella; mp – Merced phacelia; mtt – Munz's tidy-tips; ons – Oil neststraw; pbbb – Palmate-bracted bird's-beak; tp – Tejon poppy; rbr – Riparian brush rabbit; rwr – Riparian woodrat; sjas – San Joaquin antelope squirrel; sjdb – San Joaquin dune beetle; sjkf – San Joaquin kit fox; sjkr – San Joaquin kangaroo rat; sjlt – San Joaquin Le Conte's thrasher; sjwt – San Joaquin woolly-threads; snkr – Short-nosed kangaroo rat; tbw – Temblor buckwheat; tgm – Tulare grasshopper mouse; tkr – Tipton kangaroo rat; vc – Vasek's clarkia

4 Conduct important research and monitoring.

Table 10 lists important research and monitoring needs for covered species by geographic area or community. Habitat surveys and population monitoring for covered species are priorities in most geographic areas. Most research on population biology and habitat management for several species can be combined into single programs, reducing costs, increasing coverage and strengthening quality of ecosystem-level management. Large blocks of public land provide the best setting for control and execution of scientifically valid research on featured species biology and habitat management. Seed banking is included in Table 10 with research and monitoring of plant species where known populations of plants occur. Combining all of these tasks by study area reduces overall costs. When seed banking is identified as a recovery action, seed collections must be representative of the source populations and must not deplete them. Detailed guidelines for seed collection have been published by the Center for Plant Conservation (1991). See the recovery strategy section of each species account for further details on species-specific research and monitoring needs.

Table 10. ***Demographic and Other Research and Monitoring Needs for Featured Species in Upland and Riparian Communities of the San Joaquin Valley Planning Area.*** *TBD = to be determined; N/A = not applicable. See Figure 70 for the location of research areas.*

Recovery Task #	Study Area (if applicable)	Tasks and Target Species[1]	Comments	Priority
4.1	Santa Barbara Canyon, Santa Barbara Co.	effects of grazing + census + monitoring + reproduction & demography + identity of pollinators + seed banking (all tasks for **cjf**)		2
4.2	Cuyama Valley, Santa Barbara & San Luis Obispo Counties	census (**snkr**) + monitoring (**bnll, gkr, sjas, sjlt**)		3
4.3	Carrizo Plain Natural Area, San Luis Obispo Co.	competition from exotics (**cjf, sjwt**) + census (**cjf, jpg, mtt, lhsb**) + monitoring (**cjf, sjwt, hws, jpg, mtt, lhsb, tbw**) + reproduction & demography (**cjf, sjwt**) + identity of pollinators (**cjf**) + seed banking (**cjf**) + pesticide effects on pollinators (**cjf**)	**cjf**, **sjwt** censuses & reproduction & demography partly completed; fire effects on **cjf** and grazing effects on **sjwt** will be studied on same plots as for animals	2
4.4	Carrizo Plain Natural Area, San Luis Obispo Co.	effects of fire (**cjf, bnll, gkr, sjas, snkr, tgm**) + effects of grazing (**sjwt, bnll, gkr, sjas, snkr, sjlt, tgm**) + competition from Heermann's kangaroo rat (**snkr**) + census (**bnll, gkr, snkr**) + monitoring (**bnll, gkr, snkr, sjas, sjlt, tgm**) + reproduction & demography (**bnll, snkr**)	**bnll** & **gkr** censuses & reproduction & demography partly completed	2

Recovery Task #	Study Area (if applicable)	Tasks and Target Species[1]	Comments	Priority
4.5	Carrizo Plain Natural Area, San Luis Obispo Co.	effects of fire + effects of grazing + census + monitoring + reproduction & demography (all tasks for **sjkf**)	the wider-ranging kit fox requires different experimental design than for more sedentary animals & plants though some actions in habitat management can be combined for cost savings	2
4.6	Carrizo Plain Natural Area, San Luis Obispo Co.	mating & social systems (**gkr**)	some aspects of research completed or in progress	3
4.7	Kern Lake, Kern Co.	competition from exotics + census + reproduction & demography + seed banking (all tasks for **bas**)		1
4.8	Kern Lake, Kern Co.	census (**bvls**) + monitoring (**bas**, **bvls**) + reproduction & demography (**bvls**)	**bas** can be monitored at same time as **bvls** is monitored	1
4.9	Kern Lake, Kern Co.	systematics & genetics (**bas**)		2
4.10	Lokern, Kern Co.	competition from exotics (**km**) + census (**km**) + monitoring (**km**, **hws**, **lbsb**) + reproduction & demography (**km**) + identity of pollinators (**km**)	**km** reproduction & demography partly completed; grazing & fire effects on **km** will be studied on same plots as for animals	2
4.11	Lokern, Kern Co.	effects of grazing (**km**, **gkr**, **snkr**, **sjas**, **sjkf**, **sjlt**, **tgm**) + effects of fire (**km**, **gkr**, **snkr**, **sjas**, **sjkf**, **sjlt**, **tgm**) + census (**gkr**, **sjkf**, **sjlt**) + monitoring (**gkr**, **tgm**, **snkr**, **sjas**, **sjkf**. **sjlt**) + reproduction & demography (**ball**)	**gkr** census in progress at one site; **ball** reproduction & demography could be investigated at Elk Hills-Buena Vista Valley in addition or in place of this site.	1
4.12	Lokern, Kern Co.	pesticide effects on pollinators (**km**), insect prey base (**ball**, **tgm**, **sjlt**) & targeted species (**ball**, **tgm**, **sjlt**)		1
4.13	Elk Hills-Buena Vista Valley area, Kern Co.	competition from exotics (**oms**) + census (**oms**) + monitoring (**hws**, **oms**) + reproduction & demography (**oms**) + characteristics of microhabitat (**oms**) + life history (**oms**) + seed banking (**oms**)		1

Recovery Task #	Study Area (if applicable)	Tasks and Target Species [1]	Comments	Priority
4.14	Elk Hills-Buena Vista Valley area, Kern Co.	competition from Heermann's kangaroo rat (snkr) + census (sjlt) + monitoring (gkr, snkr, sjas, sjlt, tgm) + effects of grazing (bnll, gkr, snkr, sjas, sjlt, tgm)	entire region from Elk Hills-McKittrick Valley southward through Maricopa area, but centered on Naval Petroleum Reserves in California	2
4.15	Elk Hills-Buena Vista Valley area, Kern Co.	census + monitoring + reproduction & demography + dispersal + effects of grazing (all tasks for sjkf)	entire region from Elk Hills-McKittrick Valley southward through Maricopa area, but centered on Naval Petroleum Reserves in California; the wider-ranging kit fox requires different experimental design though some actions in habitat management can be combined for cost savings	2
4.16	Metropolitan Bakersfield	reproduction, demography, and dispersal (sjkf)		1
4.17	Lost Hills, Kern Co.	monitoring (hws, sjwt, lhsb) + reproduction & demography (sjwt)		2
4.18	Kern Bluffs + Kern Canyon + metro Bakersfield + Granite Station, Kern Co.	effects of grazing + effects of off-road vehicle control (bc, snkr, sjkf) (Kern Bluffs) + census + monitoring + reproduction & demography + identity of pollinators (all tasks for bc)		2
4.19	Sand Ridge (bc) + Bena- Caliente (bc, vc), Kern Co	competition from exotics + effects of off-road vehicle control (bc, snkr, sjkf) (Sand Ridge, bc; Bena Hills, vc) + effects of fire (Sand Ridge, bc) + census (bc, vc) + monitoring (bc, vc, snkr, sjas, sjkf) + reproduction & demography (bc, vc) + identity of pollinators (bc) + seed banking (vc)		1
4.20	Sand Ridge or Wheeler Ridge	pesticide effects on pollinators (bc)		2
4.21	Wheeler Ridge + Comanche Point + Cottonwood Creek + Fuller Acres, Kern Co.	effects of grazing (Wheeler Ridge) + census + monitoring + reproduction & demography + identity of pollinators (all tasks for bc)	monitoring for bc at Wheeler Ridge & Comanche Point can be combined with animal monitoring for cost savings (see next task)	2
4.22	Wheeler Ridge + Comanche Point, Kern Co.	monitoring (bnll, snkr, sjkf)		3

Recovery Task #	Study Area (if applicable)	Tasks and Target Species¹	Comments	Priority
4.23	All inhabited sites, Kern Co.	systematics & genetics (**bc**)		3
4.24	Alameda, Kern, Kings, Monterey, Santa Barbara, San Luis Obispo, Tulare, & Ventura Counties	systematics & genetics (**km**)	includes geographic range of Parry's mallow	2
4.25	Pixley National Wildlife Refuge-Allensworth Ecological Reserve, Tulare Co.	competition from Heerman's kangaroo rat (**tkr**) + effects of grazing (**bnll**, **tkr**) + effects of fire (**bnll**, **tkr**) + census (**bnll**, **tkr**, **sjkf**) + monitoring (**bnll**, **tkr**, **sjkf**) + reproduction & demography (**bnll**, **tkr**)	census for **bnll**, **tkr** partly completed; some aspects of grazing and fire management for **tkr** in progress; some aspects of reproduction and demography for **bnll**, **tkr** completed or in progress	1
4.26	Pixley National Wildlife Refuge-Allensworth Ecological Reserve, Kern National Wildlife Refuge-Semitropic Ridge Natural Area, Kern & Tulare Counties and agricultural lands as appropriate	dispersal + movements + diet + reproduction & demography + use of agricultural fields + use of artificial dens (all tasks for **sjkf**) + census + monitor + reproduction & demography (all tasks for **bvls**)	habitat management studies for **bnll**, **tkr** (see preceding task) will provide some information for habitat management for **sjkf**	1
4.27	Kettleman Hills, Kings Co.	monitoring + census + reproduction & demography + life history + land use effects (all tasks for **ddw**)		1
4.28	Kettleman Hills-Devils Den, Fresno, Kings, & Kern Counties	competition from exotics (**sjwt**) + census (**jpg**) + monitoring (**hws**, **jpg**, **sjwt**) + reproduction & demography (**sjwt**)		2
4.29	Kettleman Hills, Kings & Fresno Counties	monitoring (**bnll**, **gkr**, **snkr**, **sjas**, **sjkf**, **sjlt**)	habitat management studies (grazing, fire) & population monitoring are in progress	3
4.30	Lemoore Naval Air Station, Kings Co.	effects of grazing + effects of fire + census + monitoring (all tasks for **fkr**)	in progress	1
4.31	Kreyenhagen Hills, Fresno Co.	effects of grazing (**cjf**) + competition from exotics (**cjf**) + census (**cjf**) + monitoring (**cjf**, **tgm**, **snkr**, **sjlt**, **sjkf**)+ reproduction & demography (**cjf**) + identity of pollinators (**cjf**)+ seed banking (**cjf**) + pesticide effects on pollinators	priority is for **cjf** tasks; monitoring for other species can be accomplished during trips to study **cjf**	2

Recovery Task #	Study Area (if applicable)	Tasks and Target Species¹	Comments	Priority
4.32	Jacalitos Hills, Fresno Co.	monitoring + reproduction & demography (all tasks for **sjwt**)		2
4.33	Alkali Sink Ecological Reserve, Fresno Co.	census (**pbbb**) + monitoring (**pbbb, hws, bnll, sjkf, possibly fkr**) + reproduction & demography (**pbbb**) + seed banking (**pbbb**)	monitoring is priority 1 if **fkr** is rediscovered or reestablished there	2
4.34	Alkali Sink Ecological Reserve & Kerman Ecological Reserve, Fresno Co.	census (Kerman Ecological Reserve; **lss, lhsb**) + monitoring (Kerman Ecological Reserve; **lss, lhsb, bnll, possibly fkr**) + competition from Heermann's kangaroo rat (**fkr**)		1
4.35	W. Madera Co.	census (**pbbb, lss**) + monitoring (**pbbb, lss, bnll, sjkf, possibly fkr**) + reproduction & demography (**pbbb, bnll**) + seed banking (**pbbb**)	**pbbb** blooms and sets seeds in summer to early fall, so life cycle overlaps much of period for studying **bnll**	2
4.36	W. Madera Co. + Woodland, Yolo Co.	genetics (**pbbb**)		2
4.37	Ciervo-Panoche Natural Area, Fresno & San Benito Counties	land use effects (**casb, smkr**) + census (**jpg, smkr**) + monitoring (**sjwt, jpg, casb, sjdb**) + reproduction & demography (**sjwt, casb, sjdb**) + life history (**casb, sjdb**)	**gkr** census completed	2
4.38	Ciervo-Panoche Natural Area, Fresno & San Benito Counties	census (**sjkf**) + monitoring (**bnll, gkr, smkr, sjas, sjkf, tgm**)	**sjkf** census partly completed (northern portion of area)	2
4.39	all sites, Fresno, Kern, Kings, Merced, & San Luis Obispo Counties	systematics (**lhsb**)	study directed at relationship of Carrizo Plain Natural Area population	3
4.40	all sites, Merced Co.	systematics (**mp**)		3
4.41	all sites, Kern, Monterey, & San Luis Obispo Counties	systematics (**thw**)		3
4.42	San Luis Island, Merced Co.	census + monitoring (**lhsb**)		2
4.43	riparian communities, San Joaquin & Stanislaus Counties	population census (**rbr, rwr**) + monitoring (**rbr, rwr**) + captive breeding research (**rbr**) + experimental introduction and reintroduction (**rbr, rwr**)		1

Recovery Task #	Study Area (if applicable)	Tasks and Target Species¹	Comments	Priority
4.44	Northwest portion of range, Valley fringes on eastern & northwestern sides (Contra Costa, Alameda, San Joaquin, Stanislaus, Merced, Fresno, Kings, Kern, & Tulare Counties)	census + monitoring (sjkf)		2
4.45	Camp Roberts, Monterey & San Luis Obispo Counties	land use effects + dispersal + census + monitoring + investigate reasons for recent population declime (sjkf)	some aspects of land use effects & monitoring are in progress	2
4.46	Ft. Hunter Liggett, Monterey Co.	land use effects + dispersal + census + monitoring + investigate reasons for recent population decline (sjkf)	some aspects of land use effects & monitoring are in progress	2
4.47	Springtown, Alameda Co.	effects of grazing + monitoring + reproduction & demography + seed banking (all tasks for pbbb)		2
4.48	Springtown, Alameda Co.	hydrologic study (pbbb)	study ongoing	1
4.49	Sacramento National Wildlife Refuge complex + Woodland; Colusa, Glenn, & Yolo Counties	competition from exotics (National Wildlife Refuges only) + monitoring + reproduction & demography + seed banking (all tasks for pbbb)		2
4.50	currently verified sites in Butte, Kern, and Merced Counties	census + monitoring (hm)		2
4.51	all sites	metapopulation genetics (bnll)		3
4.52	all sites	metapopulation genetics (sjkf)	some aspects of study completed or in progress	2
4.53	all sites	population genetics (bvls)	genetics studies must be conducted prior to reintroduction efforts to ensure that animals taken to establish new populations are genetically representative of the parent population without depleting the genetic diversity of the parent population	2

Recovery Task #	Study Area (if applicable)	Tasks and Target Species¹	Comments	Priority
4.54	all sites	population genetics (rbr)	genetics studies must be conducted prior to reintroduction efforts to ensure that animals taken to establish new populations are genetically representative of the parent population without depleting the genetic diversity of the parent population	1
4.55	all sites	population genetics (rwr)	genetics studies must be conducted prior to reintroduction efforts to ensure that animals taken to establish new populations are genetically representative of the parent population without depleting the genetic diversity of the parent population	1
4.56	TBD	effects of pesticide use & drift (bvls)	potential sites are Kern Lake & Kern National Wildlife Refuge	2
4.57	TBD	kit fox-red fox-coyote interactions (sjkf)	depending on survey results implement control methods as needed	2
4.58	TBD	direct & indirect effects of rodenticide use (sjkf)	potential sites are the Pixley National Wildlife Refuge-Allensworth Natural Area-Kern National Wildlife Refuge area & the Lokern-Elk Hills area	3
4.59	TBD	census + monitoring + seed banking (bss)	depends on survey results	1
4.60	TBD	census + monitoring (cpl)	depends on survey results	2
4.61	TBD	census + monitoring + seed banking (dpcp)	depends on survey results	1
4.62	TBD	census + monitoring + seed banking (lhc)	depends on survey results	1
4.63	TBD	census + monitoring + seed banking ([illegible])	depends on survey results	1

Recovery Task #	Study Area (if applicable)	Tasks and Target Species[1]	Comments	Priority
4.64	TBD	census + monitoring (msp)	depends on survey results	2
4.65	TBD	census + monitoring (mtt)	depends on survey results	2
4.66	TBD	census + monitoring (tp)	depends on survey results	2
4.67	TBD	census + monitoring + seed banking (vc)	depends on survey results	1
4.68	N/A	salinity effects on plant structure (bss)	laboratory study	3
4.69	N/A	effects of beet leafhopper control (casb, ddw, sjdb)	laboratory study	2
4.70	N/A	publish scientific name & description (ddw)	establishing scientific validity of species status & formal naming are important in setting priorities for recovery funding	3
4.71	N/A	matrix projection modeling (cjf)	modeling should show that all protected populations are self-sustaining	3
4.72	N/A	matrix projection modeling (pbbb)	modeling should show that all protected populations are self-sustaining	3
4.73	N/A	matrix projection modeling (km)	modeling should show that all protected populations are self-sustaining	3
4.74	N/A	matrix projection modeling (sjwt)	modeling should show that all protected populations are self-sustaining	3
4.75	N/A	matrix projection modeling (bc)	modeling should show that all protected populations are self-sustaining	3
4.76	N/A	single-metapopulation viability analysis (gkr)	Model should show no greater than a 5-percent probability of extinction over a 200-year period in each of the three largest metapopulations; preliminary modeling in progress	3

Recovery Task #	Study Area (if applicable)	Tasks and Target Species¹	Comments	Priority
4.77	N/A	single-metapopulation viability analysis (fkr)	Model should show no greater than a 5-percent probability of extinction over a 200-year period for the entire population; preliminary modeling in progress	3
4.78	N/A	single-metapopulation viability analysis (tkr)	Model should show no greater than a 5-percent probability of extinction over a 200-year period for the entire population; preliminary modeling in progress	3
4.79	N/A	single-metapopulation viability analysis (bnll)	Model should show no greater than 5-percent probability of extinction over a 200-year period for five or more of seven populations; preliminary modeling in progress	3
4.80	N/A	refine spatially-explicit metapopulation viability analysis (sjkf)	Model should show no greater than 5-percent probability of extinction for entire subspecies population in 300 years; preliminary modeling in progress	3
4.81	Lawrence Livermore Laboratory, Site 300	census + monitoring + seed banking (dpcp)		1
4.82	TBD	effects of selenium (bvls)	Potential sites are Kern Lake and Kern National Wildlife Refuge	2

[1] Species

bc – Bakersfield cactus; bnll – Blunt-nosed leopard lizard; bss – Bakersfield smallscale; bvls – Buena Vista Lake shrew; casb – Ciervo aegialian scarab beetle; cjf – California jewelflower; cpl – Comanche Point layia; ddw – Doyen's dune weevil; dpcp – Diamond-petaled California poppy; fkr – Fresno kangaroo rat; gkr – Giant kangaroo rat; hws – Hoover's woolly-star; jpg – Jared's peppergrass; km – Kern mallow; lhsb – Lost Hills saltbush; lss – Lesser saltscale; mm – Merced monardella; mp – Merced phacelia; mtt – Munz's tidy-tips; ons – Oil neststraw; pbbb – Palmate-bracted bird's-beak; tp – Tejon poppy; rbr – Riparian brush rabbit; rwr – Riparian woodrat; sjas – San Joaquin antelope squirrel; sjdb – San Joaquin dune beetle; sjkf – San Joaquin kit fox; sjkr – San Joaquin kangaroo rat; sjlt – San Joaquin Le Conte's thrasher; sjwt – San Joaquin woolly-threads; snkr – Short-nosed kangaroo rat; tbw – Temblor buckwheat; tgm – Tulare grasshopper mouse; tkr – Tipton kangaroo rat; vc – Vasek's clarkia

5 Maintain and establish linkages in existing natural lands and between islands of habitat on the Valley floor and natural lands around the fringe of the Valley.

To prevent genetic isolation of populations of listed and sensitive species on the Valley floor from populations in the surrounding foothills, or the isolation of kit fox populations in any part of their range, linkages should be maintained and/or established through management or conservation agreements, incentive programs, zoning, acquisition, easements, or other mechanisms.

5.1 Establish linkages between isolated islands of habitat on the Valley floor and natural lands in the surrounding foothills.

Table 11 describes linkage areas on the Valley floor and Figure 72 shows their location. For linkages of natural habitat, such as the Chowchilla Canal and Kern River, the primary goal is to enhance natural habitat without compromising the primary function of these waterways. To establish linkages in farmlands, two programs are recommended: 1) focused retirement of drainage problem farmlands and subsequent restoration of natural habitat, (see Task 1.2.6); and 2) focused implementation of a voluntary "safe harbor" program that would establish wildlife friendly habitat areas on active farmlands (see Task 1.2.5). The resulting linkages would be a mosaic of existing natural lands, retired and restored farmland, and active farmlands with associated wildlife habitat areas.

Table 11. ***Valley Floor Linkage Areas.*** *See Figure 72 for the location of each linkage area.*

Recovery Task #	**Locality**	**County**	**Species (target in bold)**[1]	**Landowner/Comments**	**Priority**
5.1.1	Western Fresno County (Valley floor west of Fresno Slough and San Joaquin River)	Fresno	**sjkf**, snkr, bnll, hws, lhsb, lss, pbbb, **gkr**	Private farmland/ located between natural lands of western Fresno County, in the Monocline Ridge-Tumey Hills-Panoche Hills area and Mendota Wildlife Area and western Madera County, retire strategic parcels to provide continuous link of natural lands; one target area for retirement and safe harbor program is along Panoche Creek	2
5.1.2	Garces Highway	Kern, Tulare	**bnll, tkr, sjkf**, sjas, tgm	Private farmland/ located between Kern National Wildlife Refuge-Semitropic Ridge Natural Area and Pixley-Allensworth Natural Area	2
5.1.3	Highway 43	Tulare	**bnll, tkr, sjkf**	Private farmland/ located between Creighton Ranch and Pixley-Allensworth Natural Area	3
5.1.4	Semitropic Ridge to Lost Hills	Kern	**sjkf**	Private farmland/ links to Garces Highway corridor	3
5.1.5	Kettleman Hills to Anticline Ridge	Fresno, Kings, Kern	**bnll, sjkf, snkr**, tgm, sjlt	Private farmland/ links with Coalinga and Guijarral Hills and rest of natural lands on the west edge of the Valley.	2

Recovery Task #	Locality	County	Species (target in bold)[1]	Landowner/Comments	Priority
5.1.6	Kern River Alluvial Fan Area	Kern	**sjkf, tkr**	City of Bakersfield, Private/ develop and implement management plan to protect and enhance natural values while maintaining flood-protection features, connecting corridor for sjkf movements across the southern Valley.	3
5.1.7	Chowchilla Canal	Madera	pbbb, **bnll**, fkr, **sjkf**	COE/ enhance habitat values without compromising primary function, links Wildlife Areas, National Wildlife Refuges, and grasslands areas.	2
5.1.8	Sandy Mush Road	Merced	**llsb, bnll, sjkf**, lss, pbbb, fkr	Private/links Merced County National Wildlife Refuges and State areas with the northeastern and northwestern edges of the Valley and with natural areas further south in Madera and Fresno Counties	2
5.1.9	Poso Creek	Kern	**sjkf**	Kern County, Private/ links natural lands in the Sierra foothills on the east and Kern National Wildlife Refuge on the west.	3

[1] Species
bc – Bakersfield cactus; bnll – Blunt-nosed leopard lizard; bss – Bakersfield smallscale; bvls – Buena Vista Lake shrew; casb – Ciervo aegialian scarab beetle; cjf – California jewelflower; cpl – Comanche Point layia; ddw – Doyen's dune weevil; dpcp – Diamond-petaled California poppy; fkr – Fresno kangaroo rat; gkr – Giant kangaroo rat; hws – Hoover's woolly-star; jpg – Jared's peppergrass; km – Kern mallow; llsb – Lost Hills saltbush; lss – Lesser saltscale; mm – Merced monardella; mp – Merced phacelia; mtt – Munz's tidy-tips; ons – Oil neststraw; pbbb – Palmate-bracted bird's-beak; tp – Tejon poppy; rbr – Riparian brush rabbit; rwr – Riparian woodrat; sjas – San Joaquin antelope squirrel; sjdb – San Joaquin dune beetle; sjkf – San Joaquin kit fox; sjkr – San Joaquin kangaroo rat; sjlt – San Joaquin Le Conte's thrasher; sjwt – San Joaquin woolly-threads; snkr – Short-nosed kangaroo rat; tbw – Temblor buckwheat; tgm – Tulare grasshopper mouse; tkr – Tipton kangaroo rat; vc – Vasek's clarkia

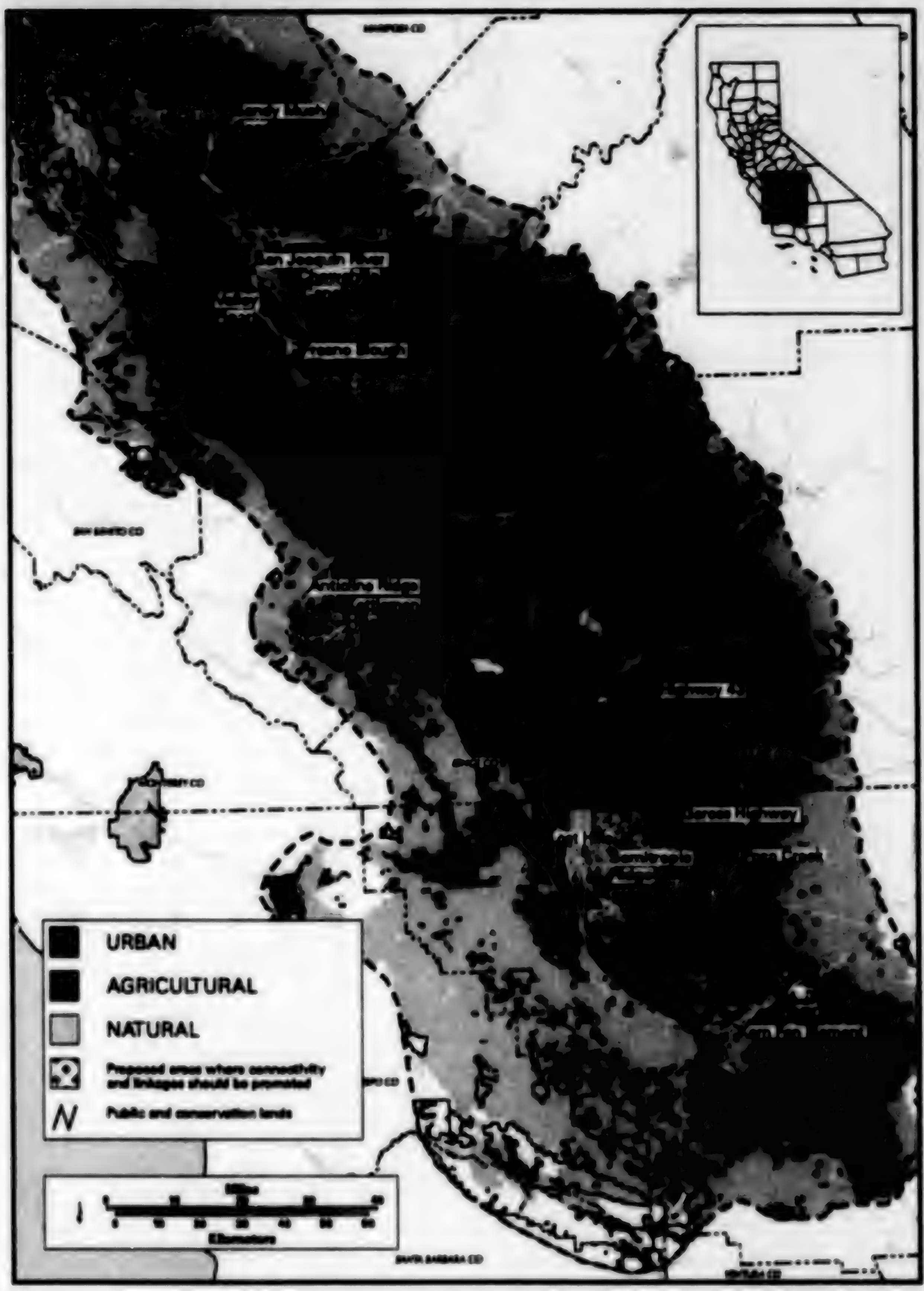


Figure 72. General locations of areas targeted as Valley floor linkages between natural communities (see table 12).

5.2 **Reintroduce featured species to enhanced and restored habitat within linkages where necessary (Priority 3).**

Once habitat restoration and enhancement has been accomplished in protected areas, appropriate featured plant and animal species should be reestablished if there are no adjacent source populations. Species such as Hoover's woolly-star, San Joaquin kit fox, kangaroo rats, and blunt-nosed leopard lizards have potential for reestablishment on restored farmlands.

5.3 **Maintain linkages of natural lands around the fringe of the Valley and elsewhere for San Joaquin kit fox and other listed and sensitive species.**

Table 12 describes linkage areas on the fringe of the San Joaquin Valley and in adjacent valleys to the west. Figure 73 depicts linkage areas in the foothills surrounding the San Joaquin Valley. Maintenance of these linkages could be achieved through zoning, safe harbor programs (Task 1.2.5), easements, or other mechanisms.

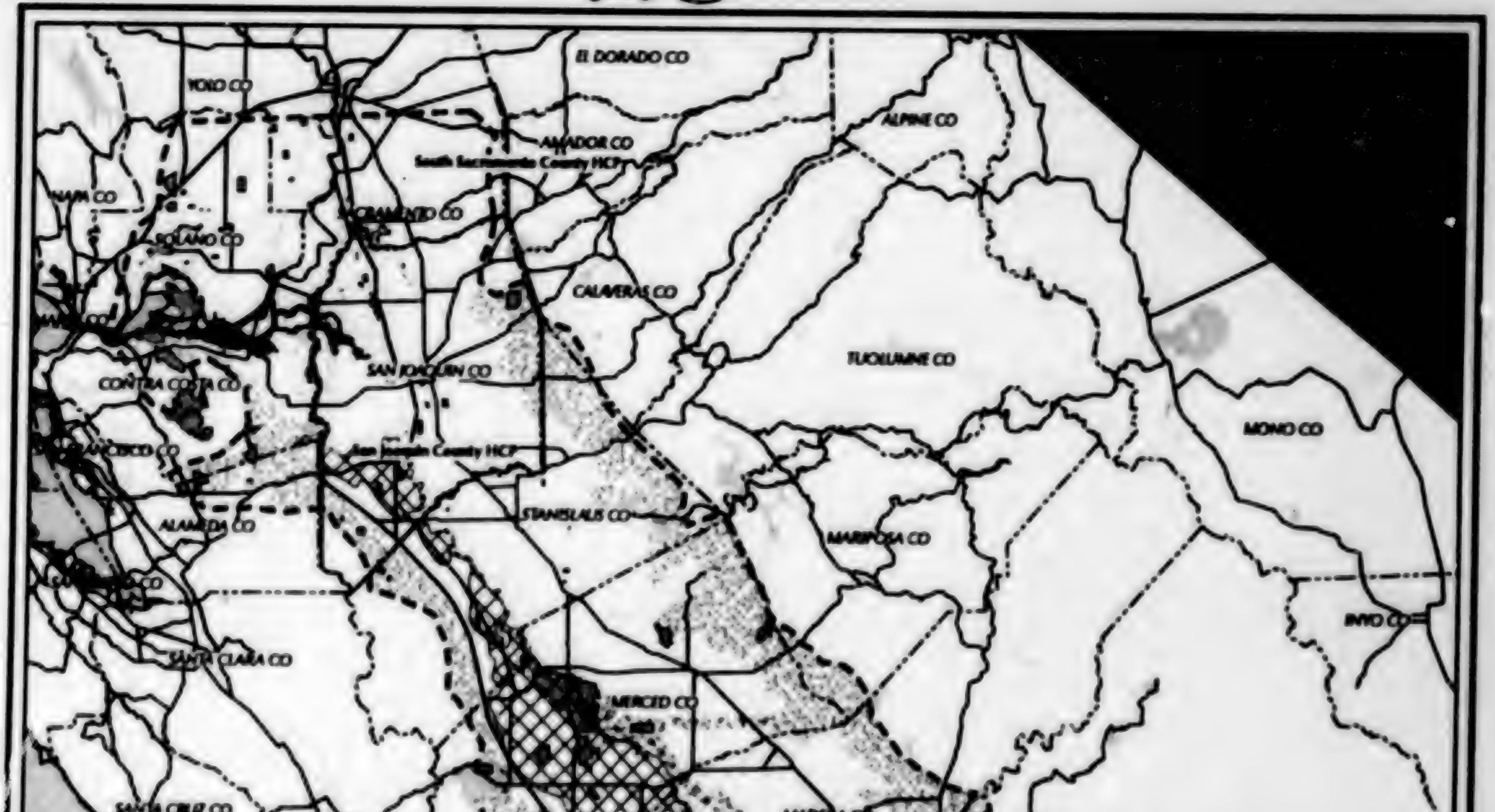
Table 12. ***Linkage Areas Around the San Joaquin Valley Edge and Elsewhere.*** *See Figure 73 for the location of linkage areas around the San Joaquin Valley.*

Recovery Task #	Locality	County	Species[1] (target in bold)	Landowner/Comments	Priority
5.3.1	Northeast Valley edge to Madera-Fresno County line	San Joaquin, Stanislaus, Merced, Madera	**sjkf, mp**, mm	Mostly private/ grassland and oak savanna communities, preserve 90 percent of existing natural lands, maintain grazing and other compatible land uses	3
5.3.2	Northwest Valley edge to Santa Nella	San Joaquin, Stanislaus, Merced	**sjkf**	Mostly private/ grassland and oak savanna communities, maintain grazing and other compatible land uses	2
5.3.3	East and Southeast Valley edge, Fresno-Tulare County boundary south to Kern River, Kern County	Tulare, Kern	**sjkf, bnll, sjas, smkr, tgm**, cjf, bc, tp, ons	Mostly private/ grassland and oak savanna communities, urbanization, maintain grazing and other compatible land uses	2
5.3.4	Western Valley edge, Santa Nella to Panoche Creek	Merced, Fresno	**sjkf, jpg, lhsb, mtt, sjas, smkr**	Mostly private/ grassland and shrubland communities, maintain grazing and other compatible land uses	2
5.3.5	Western Valley edge, Panoche Creek to Ciervo Wash	Fresno	**sjkf, jpg, hws, sjwt, bnll, gkr, sjas, smkr, tgm, sjlt**	Mostly private/ grassland and shrubland communities, maintain grazing and other compatible land uses	2
5.3.6	Western Valley edge, Ciervo Wash to Coalinga	Fresno	**sjkf, jpg, hws, sjwt, bnll, gkr, sjas, smkr, tgm, sjlt**	Mostly private/ grassland and shrubland communities, maintain grazing and other compatible land uses	2

Recovery Task #	Locality	County	Species[1] (target in bold)	Landowner/Comments	Priority
5.3.7	Western Valley edge, Coalinga to McKittrick	Fresno, Kings, Kern	**sjkf, cjf, jpg, hws, lhsb, ons, sjwt, bnll, gkr, sjas, snkr, tgm, sjlt**	Mostly private/ grassland and shrubland communities, maintain grazing and other compatible land uses	2
5.3.8	Southwest, Southern, and Southeastern Valley edge, McKittrick south to Maricopa, east and north to Kern River	Kern	**sjkf, bc, cpl, hws, ons, tp, vc, sjwt, bnll, gkr, sjas, snkr, tgm, sjlt**, cjf, lhsb, km	Mostly private/ grassland and shrubland communities, maintain grazing and other compatible land uses	2
5.3.9	Salinas/Pajaro River watershed to San Joaquin Valley	Monterey, San Benito, San Luis Obispo	**sjkf**	Private, public/ grassland and shrubland communities, preserve and enhance habitat and linkage to the San Joaquin Valley via the Estrella River and San Juan Creek watersheds, to the Carrizo Plain Natural Area, San Joaquin Valley and Kettleman Hills area, maintain grazing and other compatible land uses	2
5.3.10	Cuyama Valley to Carrizo Plain Natural Area through lower portions of Caliente Mountains	San Luis Obispo	**hws, bnll, gkr, sjas, snkr**, sjkf	Private, public/ grassland and shrubland communities, maintain grazing and other compatible land uses	3
5.3.11	Estrella River watershed	San Luis Obispo, Monterey	**dpcp, tbw, sjkf**	Private/ maintain grazing and other compatible land uses	3
5.3.12	San Juan Creek watershed	San Luis Obispo	**sjkf**, bnll, **gkr**, sjas, snkr, tgm, dpcp, sjwt, tbw	Private/ provides a significant portion of the natural lands linking Salinas Valley and Carrizo Plain Natural Area populations of the sjkf, maintain area in its current mosaic of dryland grain farms and ranch lands, many farmlands in the U.S. Department of Agriculture Conservation Reserve Program	3

[1] Species

bc – Bakersfield cactus; bnll – Blunt-nosed leopard lizard; bss – Bakersfield smallscale; bvls – Buena Vista Lake shrew; csab – Ciervo aegialian scarab beetle; cjf – California jewelflower; cpl – Comanche Point layia; ddw – Doyen's dune weevil; dpcp – Diamond-petaled California poppy; fkr – Fresno kangaroo rat; gkr – Giant kangaroo rat; hws – Hoover's woolly-star; jpg – Jared's peppergrass; km – Kern mallow; lhsb – Lost Hills saltbush; lss – Lesser saltscale; mm – Merced monardella; mp – Merced phacelia; mtt – Munz's tidy-tips; ons – Oil neststraw; pbbb – Palmate-bracted bird's-beak; tp – Tejon poppy; rbr – Riparian brush rabbit; rwr – Riparian woodrat; sjas – San Joaquin antelope squirrel; sjdb – San Joaquin dune beetle; sjkf – San Joaquin kit fox; sjkr – San Joaquin kangaroo rat; sjlt – San Joaquin Le Conte's thrasher; sjwt – San Joaquin woolly-threads; snkr – Short-nosed kangaroo rat; tbw – Temblor buckwheat; tgm – Tulare grasshopper mouse; tkr – Tipton kangaroo rat; vc – Vasek's clarkia


EL DORADO CO
YOLO CO
ALPINE CO
AMADOR CO
South Sacramento County HCP
NAPA CO
SACRAMENTO CO
SOLANO CO
CALAVERAS CO
TUOLUMNE CO
SAN JOAQUIN CO
CONTRA COSTA CO
SAN FRANCISCO CO
San Joaquin County HCP
MONO CO
STANISLAUS CO
ALAMEDA CO
MARIPOSA CO
INYO CO
SANTA CLARA CO
MERCED CO
SANTA CRUZ CO
MADERA CO
FRESNO CO
SAN BENITO CO

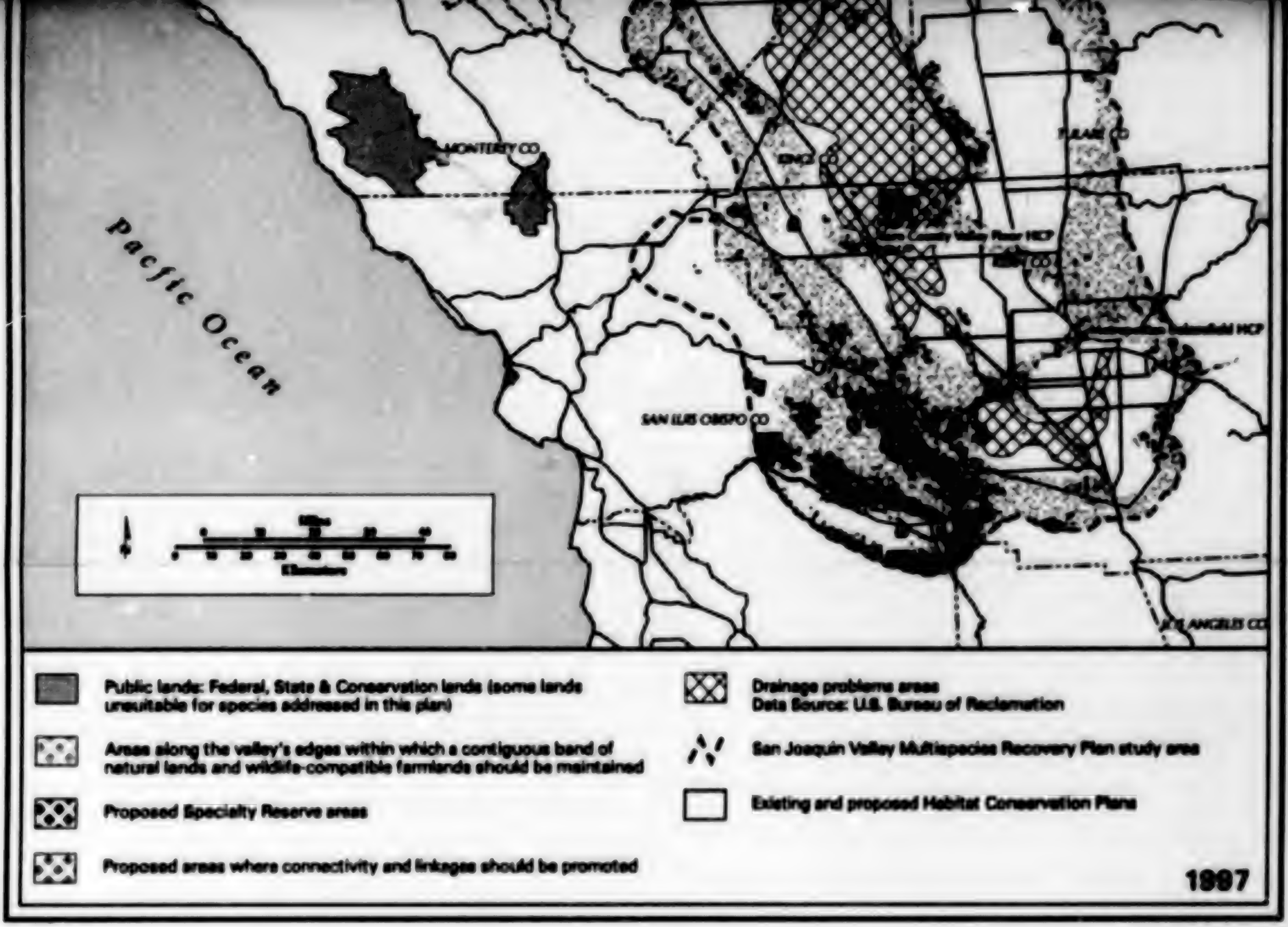

MONTEREY CO
KINGS CO
TULARE CO
Pacific Ocean
Kern County Valley Floor HCP
KERN CO
Metropolitan Bakersfield HCP
SAN LUIS OBISPO CO
Miles
Kilometers
LOS ANGELES CO
Public lands: Federal, State & Conservation lands (some lands unsuitable for species addressed in this plan)
Areas along the valley's edges within which a contiguous band of natural lands and wildlife-compatible farmlands should be maintained
Proposed Specialty Reserve areas
Proposed areas where connectivity and linkages should be promoted
Drainage problems areas
Data Source: U.S. Bureau of Reclamation
San Joaquin Valley Multispecies Recovery Plan study area
Existing and proposed Habitat Conservation Plans
1997

Figure 73. *San Joaquin Valley conservation and recovery planning overview (see table 12).*

6 Apply adaptive management to protected areas (Priority 3).

Revise or develop new management plans for protected habitat. All featured species require research on a variety of land management topics to develop the most effective prescriptions for managing protected habitat. Once appropriate research has been conducted, results should be applied to protected areas. Based on results of research and monitoring, existing management plans should be revised or new plans developed to maximize the value of protected habitat for featured species.

7 If necessary, reintroduce selected featured species to appropriate habitat within their historic range.

Several featured species may require reintroduction to appropriate habitat within their historic range if surveying efforts do not discover enough extant populations to meet delisting criteria. Specific sites for reintroducing these species are currently unknown.

7.1 Reintroduce Doyen's dune weevil to appropriate habitat (Priority 3).

Sites for reintroduction depend on results of life history studies as well as surveying for extant populations and identifying suitable habitat for reintroduction.

7.2 Propagate and reintroduce Bakersfield smallscale to appropriate habitat (Priority 1).

If populations of pure Bakersfield smallscale are identified through research or surveys, propagate the species in the greenhouse to produce a sufficient amount of seed, then reintroduce to historic habitat on the Valley floor.

7.3 Reintroduce Comanche Point layia to appropriate habitat (Priority 2).

Using seed collected from populations in the wild or stored in seed banks, reintroduce Comanche Point layia to appropriate habitat on the Valley floor.

7.4 Propagate and reintroduce California jewelflower to appropriate habitat (Priority 2).

Propagate California jewelflower in greenhouses to produce sufficient seed, then reintroduce to appropriate habitat within the historic range, including the Valley floor.

7.5 Reintroduce Vasek's clarkia to appropriate habitat (Priority 2).

Propagate Vasek's clarkia in greenhouses to produce sufficient seed, then reintroduce to appropriate habitat within the historic range.

7.6 Propagate and reintroduce diamond-petaled California poppy to appropriate habitat (Priority 1).

Propagate diamond-petaled California poppy in greenhouses to produce sufficient seed, then reintroduce to appropriate habitat within the historic range.

7.7 Propagate and reintroduce Merced monardella to appropriate habitat (Priority 1).

Propagate Merced monardella in greenhouses to produce sufficient seed, then reintroduce to appropriate habitat within the historic range.

7.8 Reintroduce riparian brush rabbit, riparian woodrat, Buena Vista Lake shrew, if necessary.

7.8.1 Reintroduce riparian brush rabbit to appropriate habitat in conjunction with captive propagation (Priority 1).

7.8.2 Reintroduce riparian woodrat to appropriate habitat (Priority 1).

7.8.3 Reintroduce Buena Vista Lake shrew to appropriate habitat (Priority 1).

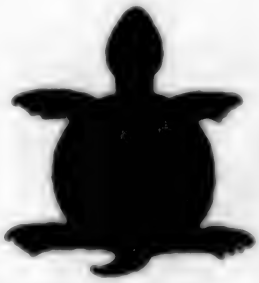
8 Periodically review the status of candidates and species of concern to determine if listing as endangered or threatened is necessary.

One of the objectives of this recovery plan is to ensure the long-term conservation of candidates and other species of concern by carrying out tasks specific to the needs of these species. However, if these tasks are not undertaken within a reasonable amount of time, listing of many of these species may be appropriate, thereby providing the protection of formal listing under the Endangered Species Act. Table 13 lists the species requiring this status review and the time frame for conducting this review.

Table 13. ***Status Review Requirements for Candidates and Other Species of Concern Featured in this Recovery Plan.***

Recovery Task #	Species	Federal Status	Needed Review	Priority
8.1	Lesser saltscale	species of concern	reevaluate status within 5 years of recovery plan approval or when surveys completed, whichever is less	3
8.2	Bakersfield smallscale	species of concern	reevaluate status within 5 years of recovery plan approval	3
8.3	Lost Hills saltbush	species of concern	reevaluate status within 10 years of recovery plan approval or when surveys completed, whichever is less	3
8.4	Vasek's clarkia	species of concern	reevaluate status within 5 years of recovery plan approval	3
8.5	Temblor buckwheat	species of concern	reevaluate status within 10 years of recovery plan approval or when surveys completed, whichever is less	3
8.6	Tejon poppy	species of concern	reevaluate status within 10 years of recovery plan approval or when surveys completed, whichever is less	3
8.7	Diamond-petaled California poppy	species of concern	reevaluate status within 5 years of recovery plan approval or when surveys completed, whichever is less	3
8.8	Comanche Point layia	species of concern	reevaluate status within 5 years of recovery plan approval or when surveys completed, whichever is less	3
8.9	Munz's tidy-tips	species of concern	reevaluate status within 10 years of recovery plan approval or when surveys completed, whichever is less	3
8.10	Jared's peppergrass	species of concern	reevaluate status within 10 years of recovery plan approval or when surveys completed, whichever is less	3
8.11	Merced monardella	species of concern	reevaluate status within 5 years of recovery plan approval or when surveys completed, whichever is less	3

Recovery Task #	Species	Federal Status	Needed Review	Priority
8.12	Merced phacelia	species of concern	reevaluate status within 10 years of recovery plan approval or when surveys completed, whichever is less	3
8.13	Oil neststraw	species of concern	reevaluate status within 5 years of recovery plan approval	3
8.14	Ciervo aegialian scarab beetle	species of concern	reevaluate status within 5 years of recovery plan approval or when new information is available, whichever is less	3
8.15	San Joaquin dune beetle	species of concern	reevaluate status within 5 years of recovery plan approval or when new information is available, whichever is less	3
8.16	Doyen's dune weevil	species of concern	reevaluate status within 3 years of recovery plan approval	3
8.17	San Joaquin antelope squirrel	species of concern	reevaluate status within 3 years of recovery plan approval	3
8.18	Short-nosed kangaroo rat	species of concern	reevaluate status within 3 years of recovery plan approval	3
8.19	Tulare grasshopper mouse	species of concern	reevaluate status within 5 years of recovery plan approval	3
8.20	Buena Vista Lake shrew	Candidate	reevaluate status within 3 years of recovery plan approval	3
8.21	San Joaquin Le Conte's thrasher	species of concern	reevaluate status within 5 years of recovery plan approval or when new information is available, whichever is less	3



V. IMPLEMENTATION SCHEDULE

Priorities in the Implementation Schedule are arranged in two tiers. Priority numbers (column 1 of the schedule) are the priorities defined in section IV. Priority numbers are organized into tiers or levels of descending priority—that is, within a tier all tasks with the same priority number are of approximately equal priority, but Tier-1 tasks have higher priority than Tier-2 tasks, and so on within that priority rank. Where possible, tasks within a tier are ordered in descending priority, at least in the sense that one or more tasks may have to be started or completed before another task can be accomplished. Yet it should be apparent that no linear hierarchy can suitably express the complex interrelationships between tasks. To accomplish the goal of recovering the ecosystems of which they are parts, and consequently this suite of species, all tasks have to be successfully executed.

Some tasks likely will take considerable time to complete, and some are going to be much more difficult to accomplish because they involve more diverse interest groups. Tasks that are mostly or solely within the jurisdiction of governmental agencies are listed before other, similar tasks involving private entities because the former should be more easily accomplished at lower costs and will put the focus of recovery actions on public lands and agencies. Many of the research tasks are best combined into single research programs for both economy and timeliness, but are listed separately for purposes of costing.

Definition of task priorities:

Priority 1—An action that must be taken to prevent extinction or prevent the species from declining irreversibly in the foreseeable future.

Priority 2—An action that must be taken to prevent a significant decline in species population or habitat quality, or some other significant negative impact short of extinction.

Priority 3—All other actions necessary to meet the recovery objectives.

Definition of task durations:

Continual—A task that will be implemented on a routine basis once begun.

Ongoing—A task that is currently being implemented and will continue until action is no longer necessary.

Unknown—Either task duration or associated costs are not known at this time.

Key to Acronyms used in the Implementation Schedule

Responsible parties:

BOR—Bureau of Reclamation
Caltrans—California Department of Transportation
CANG—California Army National Guard
CDFA—California Department of Food & Agriculture
CDFG—California Department of Fish & Game
CDPR—California Department of Parks & Recreation
CDWR—California Department of Water Resources
CEC—California Energy Commission
CEPA—California Environmental Protection Agency
COE—Army Corp of Engineers
CPNA—Carrizo Plain Natural Area
DOD—Department of Defense
DOE—Department of Energy
ER—Ecological Reserve
KWBA—Kern Water Bank Authority
KCWA—Kern County Water Agency
local—local government
NAS—Naval Air Station
NPRC—Naval Petroleum Reserves in California
NWR—National Wildlife Refuge
ROW—Right of way
TBD—To Be Determined
TNC—The Nature Conservancy
USBLM—Bureau of Land Management
USDA—Department of Agriculture
USFS—Forest Service
USFWS—Fish & Wildlife Service
USN—Navy

Implementation Schedule for Upland Species, San Joaquin Valley, California. Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.

Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
						Total Costs	FY01	FY02	FY03	FY04	
1	1	2.1.1	Protect & secure listed species habitat at Elk Hills and Buena Vista Valley	ongoing	DOE/USFWS/ Occidental	5	2	1	1	0.5	
1	1	2.1.4	Protect natural lands on Valley floor & piedmont slopes of western Kern Co.	ongoing	CDFG/CDWR/ USFWS/ USBLM	1.75	0.5	0.5	0.5	0.25	This task is for administrative actions only; depends on 1.2.2
1	1	2.1.7	Protect natural land in the Pixley NWR-Allensworth NA area	ongoing	USFWS/ CDFG/ local	TBD					Partly depends on 1.2.2
1	1	2.2.3	Protect & restore riparian habitat for riparian brush rabbits and woodrats on Stanislaus River, particularly at Caswell State Park	6 years	COE/USFWS/ CDFG/CDPR	6	1.5	1.5	1.5	1.5	
1	1	2.2.6	Expand, restore, & protect Fresno kangaroo rat habitat at Lemoore NAS	ongoing	USN/USFWS	10	1.3	3.5	2	2	Includes management research, retirement of agricultural ground, & adaptive management
1	1	2.2.19	Protect natural land & establish specialty reserve for Bakersfield cactus at Sand Ridge	ongoing	USFWS/ CDFG/ COE/TNC/ local	TBD					Depends partly on 1.2.2; protection ongoing
1	1	4.43	Conduct multiple research tasks for riparian species in San Joaquin & Stanislaus Counties	ongoing	USFWS/ CDFG/ CDPR	TBD	0.3	0.3	0.3	0.3	Monitoring ongoing; census indefinitely
1	1	4.54	Conduct population genetics research on the riparian brush rabbit	2 years	USFWS/ CDFG/ CDPR/COE	0.8	0.4	0.4			
1	1	4.55	Conduct population genetics research on the riparian woodrat	2 years	USFWS/ CDFG/ CDPR/COE	0.8	0.4	0.4			

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***Implementation Schedule for Upland Species, San Joaquin Valley, California.** Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.*

Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimates (in $100,000 units)					Comments/Notes
						Total Costs	FY01	FY02	FY03	FY04	
1	2	2.1.12	Protect, restore & enhance the Carrizo Plain Natural Area	ongoing	USBLM/ CDFG/TNC/ private	30	5	5	5	5	
1	2	2.1.14	Protect natural lands in the Ciervo-Panoche Natural Area	ongoing	USBLM/ CDFG/ private	18	3	3	3	3	Depends partly on 1.2.2
1	2	2.1.15	Protect & manage natural lands adaptively in the Kreyenhagen Hills	ongoing	USBLM/ private	2	0.5	0.5	0.5	0.2	Depends partly on 1.2.2
1	2	2.1.17	Protect & manage lands appropriately in the Kerman & Alkali Sink ERs	ongoing	CDFG	2.5	0.5	0.5	0.5	0.5	
1	2	2.2.1	Protect & enhance habitat for palmate-bracted bird's beak on City of Woodland property	ongoing	USFWS/local	TBD					Depends partly on 1.2.2
1	2	2.2.2	Protect, restore, & enhance habitat for palmate-bracted bird's beak at Sprintown Alkali Sink	ongoing	USFWS/ CDFG/ local/private	TBD					Depends partly on 1.2.2, 4.47
1	2	2.2.24	Protect habitat for Doyen's dune weevil in Caltrans ROW, conduct survey to determine land ownership	ongoing	Caltrans	0.75	0.25	0.25	0.25		
1	2	3.1	Establish a program & protocol for general & directed surveys for featured species	1 year	USFWS/ CDFG/ USBLM	1	1				Relates to program establishment and protocol development only
1	2	4.11	Conduct multiple research & monitoring tasks for multiple animal & one plant species in the Lokern	ongoing	USFWS/ CDFG/ USBLM/ CDWR/ CEC/private	9.0	2.5	7.5	1.6	1.7	Research for 5-year minimum; monitoring ongoing
1	2	4.16	Conduct multiple research tasks on San Joaquin kit fox in Metropolitan Bakersfield	ongoing	USFWS/ CDFG/county	TBD					

Implementation Schedule for Upland Species, San Joaquin Valley, California. Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.

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						Total Costs	FY01	FY02	FY03	FY04	
1	2	4.26	Conduct multiple research task on the kit fox and census and demography data on the Buena Vista Lake shrew in southern Tulare & northern Kern counties	5 years	USFWS/ CDFG/ BOR	5.2	1	1	1	1.1	
1	2	4.30	Conduct multiple habitat related research tasks at Lemoore NAS for Fresno kangaroo rat	6-10 years	USN/USFWS/ USBLM	8.85	1.35	1.35	1.35	1.6	USBLM assistance with prescribed burning
1	2	4.34	Conduct multiple research tasks in the Kerman & Alkali Sink ERs for multiple plant & animal species	ongoing	USFWS/ CDFG	1.25	0.25	0.25	0.25	0.25	Monitoring ongoing; research 5 years
1	2	4.48	Research hydrology at Springtown Alkali Sink	3 years	USFWS/local/ private	0.5	0.3	0.1	0.1		Study ongoing
1	2	4.81	Census, monitor, & bank seeds of diamond-petaled California poppy at Lawrence Livermore Lab	ongoing	DOE/USFWS/ CDFG	0.3	0.15	0.15			Monitoring ongoing
1	3	2.1.3	Protect, restore, & enhance upland & wetland communities on Kern Fan Element for Bakersfield smallscale, & other species, and consider habitat enhancement and introduction of Buena Vista Lake shrew	5 years	USFWS/BOR/ KWBA/ KCWA/ private	5	1	1	1	1	In conjunction with development of water-banking facilities; depends partly on 1.2.2
1	3	2.1.5	Protect natural lands in western Madera Co.	TBD	USFWS/BOR/ CDFG/private	TBD					Privately owned grazing land; depends partly on 1.2.2
1	3	2.1.10	Protect natural land in Kettleman Hills	ongoing	USFWS/ USBLM/ CDFG/ CDPR/BOR	TBD					Depends partly on 1.2.2

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Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $000,000 units)					Comments/Notes
						Total Costs	[illegible]	[illegible]	[illegible]	[illegible]	
1	3	2.2.22	Protect natural land & establish speciality reserve for Bakersfield cactus at Mettler-Wheeler Ridge area	ongoing	USFWS/ CDFG/ CDWR/local	TBD					Partly depends on 1.2.2
1	3	3.2.1	Conduct surveys for target plant species in the Comanche-Tejon Hills	3 years	USFWS/ CDFG	0.45	0.15	0.15	0.15		
1	3	3.2.2	Conduct surveys for target plant species in the Caliente-Bena Hills	3 years	USFWS/ CDFG/ USBLM	0.45	0.15	0.15	0.15		
1	3	3.2.4	Conduct surveys for target plant species in southern Valley alkali sinks in summer-fall	3 years	USFWS/ CDFG/ USBLM	0.45	0.15	0.15	0.15		
1	3	3.2.5	Complete surveys for target plant species in Valley alkali sinks north of Kern Co. in summer-fall	3 years	USFWS	0.5	0.2	0.2	0.1		
1	3	3.2.7	Conduct surveys for target plant species at Elk Hills	ongoing	Occidental	0.45	0.15	0.15	0.15		Complete DOE requirement
1	3	3.2.8	Conduct surveys for target plant species on the west side of the southern Valley	3 years	USFWS/ USBLM/ CDFG	0.6	0.2	0.2	0.2		
1	3	3.2.12	Conduct surveys in historic locations for the diamond-petaled California poppy	3 years	USFWS/ USBLM/ CDFG	0.6	0.2	0.2	0.2		
1	3	3.2.15	Conduct surveys for Merced monardella in suitable habitat within historic range	3 years	USFWS/COE/ CDFG	0.45	0.15	0.15	0.15		
1	3	3.2.26	Conduct surveys for riparian species in San Joaquin & Stanislaus Counties	3 years	FWS/COE/ CDFG	0.6	0.2	0.2	0.2		

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						Total Costs	FY01	FY02	FY03	FY04	
1	3	3.2.30	Conduct surveys for Buena Vista Lake shrew in southern Valley wetlands (includes target plant species)	3 years	USFWS/ CDFG/BOR/ KWBA	0.6	0.2	0.2	0.2		
1	3	4.19	Conduct multiple research & monitoring tasks for multiple species in the Sand Ridge & Bena-Caliente area	ongoing	USFWS/ CDFG/COE/ TNC	5	1	1	1	1	Monitoring ongoing; research 5 years
1	3	4.27	Conduct multiple research tasks for Doyen's dune weevil in the Kettleman Hills	5 years	USFWS/ Caltrans	1	0.1	0.2	0.3	0.3	
1	3	7.6	Propagate diamond-petaled California poppy in greenhouses & reintroduce to appropriate habitat as necessary	TBD	USFWS/ CDFG	0.8	0.3	0.3	0.2		Depends on finding seed sources
1	3	7.7	Propagate Merced monardella in greenhouses & reintroduce to appropriate habitat as necessary	TBD	USFWS/ CDFG	0.5					Depends on finding extant population
1	4	2.2.4	Protect, restore, & enhance habitats for riparian brush rabbit & riparian woodrat on San Joaquin River NWR	10 years	USFWS/COE/ local	8	2.5	1	1	1	
1	4	2.2.5	Protect, restore & manage riparian & upland habitat along the San Joaquin River in Merced Co.	15 years	USFWS/COE/ BOR/CDFG/ CDPR/local	10	0.5	2	2	1	
1	4	2.2.7	Protect natural land north of the Tulare Lake Bed for Fresno kangaroo rats & other species in Kings Co.	TBD	USFWS/ CDFG/ local/private	TBD					Private grazing land
1	4	2.2.14	Develop specialty reserve for Bakersfield cactus in Kern Bluffs area	TBD	USFWS/ CDFG/ local/private	TBD					Depends partly on 1.2.2

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						Total Costs	[illegible]	[illegible]	[illegible]	[illegible]	
1	4	2.2.21	Protect & restore natural communities at Kern Lake for Buena Vista Lake shrew & Bakersfield smallscale	5 years	USFWS/BOR/ KWBA/ private	5	2	1	1	0.5	Depends on 1.2.2
1	4	2.2.23	Protect natural communities for California jewelflower & other featured species at Santa Barbara Canyon	TBD	USFS/FWS/ CDFG/BLM/ private	TBD					Depends partly on 1.2.2
1	4	2.2.25	Develop & implement management plans for palmate-bracted bird's-beak at Colusa, Delevan, & Sacramento NWRs	ongoing	FWS	5.8	2.2	0.9	0.9	0.9	Research 5 years; monitoring ongoing
1	4	2.2.26	Develop & implement management plan for diamond-petaled California poppy at Lawrence Livermore Lab	ongoing	DOE	1.3	0.5	0.2	0.2	0.2	
1	4	4.7	Conduct multiple research tasks on Bakersfield smallscale at Kern Lake	5 years	USFWS/ CDFG/ local/ private	5	1	1	1	1	
1	4	4.8	Conduct multiple research tasks & monitoring for the Buena Vista Lake shrew at Kern Lake	ongoing	USFWS/BOR/ KWBA	1	0.5	0.5	0.5	0.1	
1	4	4.25	Conduct multiple research tasks & monitoring of multiple animal species at Pixley NWR/Allensworth ER	ongoing	USFWS/CDFG	10	2	2	2	2	Monitoring ongoing; research 6 years
1	4	7.2	Propagate Bakersfield smallscale in greenhouses & reintroduce to appropriate habitat as necessary	TBD	USFWS/ CDFG/ local/private	0.8	0.3	0.3	0.2		Depends on survey results

Implementation Schedule for Upland Species, San Joaquin Valley, California. *Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.*

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						Total Costs	FY01	FY02	FY03	FY04	
1	5	2.2.18	Protect natural land in Bena Hills-Caliente Hills & develop speciality reserves for multiple plant species	ongoing	USFWS/ private	TBD					Depends on 1.2.2
1	5	2.2.20	Protect natural land in Comanche-Tejon hills & develop speciality reserves for multiple plant species	ongoing	USFWS/ private	TBD					Depends on 1.2.2
1	5	3.2.18	Conduct surveys for upland vertebrates on the northern Valley floor	3 years	USFWS/ CDFG	0.8	0.5	0.2	0.1		
1	5	4.12	Conduct pesticide related research for multiple species in the Lokern	5 years	USFWS/ CDFG/ USBLM/ CDFA/CEPA	12.5	2.5	2.5	2.5	2.5	
1	5	4.13	Conduct multiple research tasks & monitoring for oil neststraw & Hoover's woolly-star in the Elk Hills-Buena Vista Valley area	ongoing	USFWS/DOE/ private	7.455	1.515	1.485	1.485	1.485	Monitoring ongoing; prevent disturbance; research 5 years
1	5	4.59	Census, monitor & bank seeds of any populations of Bakersfield smallscale	TBD	USFWS/CDFG/ CDWR/local/ private	TBD					
1	5	4.61	Census, monitor & bank seeds of any populations of diamond-petaled California poppy	TBD	USFWS/CDFG	TBD					
1	5	4.62	Census, monitor & bank seeds of any populations of lesser saltscale	TBD	USFWS/CDFG	TBD					
1	5	4.63	Census, monitor & bank seeds of any populations of Merced monardella	TBD	USFWS/CDFG	TBD					

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Implementation Schedule for Upland Species, San Joaquin Valley, California. *Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.*

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						Total Costs	FY01	FY02	FY03	FY04	
1	5	4.67	Census, monitor & bank seeds of any populations of Vasek's clarkia	TBD	USFWS/ CDFG	TBD					
1	5	7.8.1	Reintroduce riparian brush rabbit in conjunction with captive propagation	TBD	USFWS/ CDFG	TBD					
1	5	7.8.2	Reintroduce riparian woodrat	TBD	USFWS/ CDFG	TBD					
1	5	7.8.3	Reintroduce Buena Vista Lake shrew	TBD	USFWS/ CDFG	TBD					
2	1	1.1	Develop regional cooperative program that coordinates land use planning & biodiversity conservation	ongoing	USFWS/ CDFG/ BOR/ USBLM/ others	TBD	1	1	1	1	
2	1	1.2.1	Develop & implement an outreach plan	ongoing	USFWS/ others	TBD	0.5	0.4	0.3	0.3	
2	1	1.2.2	Develop economic incentives for conserving listed species & natural communities on private lands	TBD	USFWS/ CDFG/ private	TBD					Depends on legislation
2	1	1.2.6	Coordinate retirement of farmlands with drainage problems with recovery needs of featured species	TBD	BOR/USFWS/ CDWR	TBD	1	1	1	1	
2	1	2.1.6	Protect natural lands in northcentral Fresno Co.	ongoing	USFWS/BOR	TBD					Depends on 1.2.2
2	1	2.1.19	Protect & maintain compatible land uses in the northwestern portion of the kit fox range	ongoing	USFWS/ CDFG/ local/private	TBD					Partly depends on 1.2.2
2	1	2.2.8	Develop specialty reserve for Bakersfield cactus in Granite Station area	TBD	USFWS/ private	TBD					Depends on 1.2.2

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						Total Costs	FY01	FY02	FY03	FY04	
2	1	4.1	Conduct multiple research & monitoring tasks for California jewelflower in Santa Barbara Canyon	ongoing	USFS/ USFWS/ USBLM/ CDFG	1.7	0.975	0.2		0.525	Monitoring ongoing
2	1	4.3	Conduct multiple research & monitoring tasks for multiple plant species on the Carrizo Plain	ongoing	USFWS/ CDFG/ BLM/TNC	TBD	2.75	1.45	1.25	2.45	Monitoring ongoing; research 5-10 years
2	1	4.4	Conduct multiple research & monitoring tasks for multiple animal species on the Carrizo Plain	ongoing	USBLM/ USFWS/ CDFG/TNC	TBD	1.5	1.5	1.5	1.5	Monitoring ongoing; research for 5 years
2	1	4.5	Conduct multiple research & monitoring tasks for the kit fox on the Carrizo Plain	ongoing	USBLM/ USFWS/ CDFG/TNC	9.8	1.75	1.5	1.5	1.7	Monitoring ongoing; research 5-6 years
2	1	4.57	Determine interactions & effects on kit foxes of red foxes, coyotes, & feral dogs, and implement control methods as needed	5 years	USFWS/ CDFG	8.7	1.8	1.6	1.7	1.8	
2	1	5.3.9	Maintain & enhance habitat for San Joaquin kit fox in Salinas River-Pajaro River watersheds	ongoing	USFWS/CDFG/ USBLM/local/ private	TBD					Depends on 1.2.2
2	2	1.2.3	Encourage & assist local entities in developing & implementing large-area HCPs	ongoing	USFWS/CDFG/ local/private/ USBLM	TBD					Depends partly on 1.2.2
2	2	1.2.4	Encourage & assist in development & implementation of mitigation banks	ongoing	USFWS/CDFG/ local/private/ USBLM	TBD					
2	2	1.2.5	Encourage & assist land owners & private interest groups in developing safe-harbor programs	ongoing	USFWS/CDFG/ local/private	TBD					Depends on 1.2.2

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Implementation Schedule for Upland Species, San Joaquin Valley, California. Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.

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						Total Costs	FY01	FY02	FY03	FY04	
2	2	2.1.2	Protect San Joaquin kit fox habitat on Camp Roberts & Fort Hunter Liggett	ongoing	DOD/CANG/ USFWS	TBD					
2	2	3.2.3	Conduct surveys for target plant species at Rancheria Gulch/Adobe Canyon	2 years	USFWS/CDFG	0.35	0.2	0.15			
2	2	3.2.4	Conduct surveys for target plant species in southern Valley alkali sinks in spring	2 years	USFWS/CDFG	0.4	0.2	0.2			
2	2	3.2.5	Conduct surveys for target plant species in Valley alkali sinks north of Kern County in spring	2 years	USFWS/CDFG	0.4	0.2	0.2			
2	2	3.2.6	Conduct surveys for target plant species in alkali sinks in the Sacramento Valley	2 years	USFWS/CDFG	0.4	0.2	0.2			
2	2	3.2.9	Conduct surveys for California jewelflower at Cottonwood Pass	2 years	USFWS/CDFG	0.2	0.1	0.1			
2	2	3.2.10	Conduct surveys for Temblor buckwheat in historic locations outside of Elk Hills	2 years	USFWS/CDFG/ USBLM	0.45	0.25	0.2			
2	2	3.2.11	Conduct surveys for Tejon poppy in the Salt Creek area	2 years	USFWS/CDFG/ USBLM	0.2	0.1	0.1			
2	2	3.2.13	Conduct surveys for Munz's tidy-tips in historic locations in San Luis Obispo Co.	2 years	USFWS/CDFG/ USBLM	0.2	0.1	0.1			
2	2	3.2.14	Conduct surveys for Jared's peppergrass in historic locations	2 years	USFWS/CDFG/ USBLM	0.4	0.2	0.2			
2	2	3.2.16	Conduct surveys for Merced phacelia in historic locations	2 years	USFWS/CDFG	0.2	0.1	0.1			
2	2	4.24	Conduct systematics & genetics research on Kern mallow	2 years	USFWS/CDFG/ USBLM	0.7	0.4	0.3			

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						Total Costs	FY01	FY02	FY03	FY04	
2	2	4.36	Conduct genetics research on palmate-bracted bird's-beak populations in Woodland & W. Madera Co.	2 years	USFWS/CDFG	0.6	0.4	0.2			
2	2	4.45	Conduct multiple research tasks & monitoring for the kit fox at Camp Roberts	ongoing	DOD/CANG/ USFWS	TBD	1	1	1	1	Monitoring ongoing; research 5-10 years
2	2	4.46	Conduct multiple research tasks & monitoring for the kit fox at Fort Hunter Liggett	ongoing	DOD/USFWS	TBD	1	1	1	1	Monitoring ongoing; research 5-10 years
2	2	5.1.7	Enhance natural values of Chowchilla Bypass easement properties as a linkage for listed species	ongoing	USFWS/COE/ BOR	TBD	0.2	0.1			Graze outer banks of levees; should generate revenue
2	3	2.1.9	Protect & enhance natural lands in Sandy Mush Road & S. Grasslands areas, Merced Co.	ongoing	USFWS/CDFG/ local/private	TBD					Depends on 1.2.2
2	3	2.2.9	Protect natural land for multiple plant species in the Devil's Den area	ongoing	USFWS/CDFG/ USBLM	TBD					Depends on 1.2.2
2	3	2.2.10	Protect natural land for multiple plant species in the Lost Hills-Buena Vista Slough area	ongoing	USFWS/CDFG/ USBLM	TBD					Depends on 1.2.2
2	3	2.2.11	Protect natural land for Hoover's woolly-star & lesser saltscale in Jerry Slough/Hwy 58 area	ongoing	USFWS/CDFG	TBD					Depends on 1.2.2
2	3	2.2.12	Protect natural land for Bakersfield cactus & other species in Greater Bakersfield, north of Kern River	ongoing	USFWS/CDFG/ local/private	TBD					Depends on 1.2.2
2	3	2.2.13	Protect natural land for Bakersfield cactus in Fairfax Road-Hwy 178-Hwy 184 area	ongoing	USFWS/CDFG/ local/private	TBD					Depends on 1.2.2

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Implementation Schedule for Upland Species, San Joaquin Valley, California. Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.

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						Total Costs	FY01	FY02	FY03	FY04	
2	3	2.2.15	Protect natural land for Bakersfield cactus in the Fuller Acres area	ongoing	USFWS/CDFG/ local/private	TBD					Depends on 1.2.2
2	3	2.2.16	Protect natural land & establish speciality reserve for Bakersfield cactus at Mouth of Kern Canyon	ongoing	USFWS/CDFG/ local	TBD	0.25				Depends on 1.2.2; cost for fencing
2	3	2.2.17	Protect natural land for Bakersfield cactus in the Cottonwood Creek area	ongoing	USFWS/CDFG	TBD					Depends on 1.2.2
2	3	4.10	Conduct multiple research & monitoring tasks for multiple plant species in the Lokern	ongoing	USFWS/ USBLM/ CDFG/ CDWR/CEC/ private	TBD	1.55	1.43	1.43	1.18	Monitoring ongoing; research 5-10 years
2	3	4.14	Conduct multiple research & monitoring tasks for multiple animal species in the Elk Hills-Buena Vista Valley area	ongoing	USFWS/DOE/ Private	7.5	1.5	1.5	1.5	1.5	Research for 5 years minimum; monitoring ongoing
2	3	4.15	Conduct multiple research & monitoring tasks for San Joaquin kit fox in the Elk Hills-Buena Vista Valley area	ongoing	DOE/ USFWS/Private	10	2	2	2	2	Monitoring ongoing; research for 5 years
2	3	4.56	Research the effects of pesticide use & drift on Buena Vista Lake shrews	5 years	CDFA/CDFG/ CEPA/ USFWS	1.5	0.3	0.3	0.3	0.3	
2	3	5.1.1	Restore habitat & habitat linkages for kit foxes on the Valley floor, western Fresno Co.	TBD	BOR/USFWS/ BLM/private	TBD					Depends partly on 1.2.2
2	3	5.1.5	Link Kettleman Hills with Guijarral & Coalinga Hills & Anticline Ridge by restoring & protecting habitat for upland species	ongoing	USFWS/ USBLM/ CDFG/ private/local	TBD	1	1	1		Depends partly on 1.2.2

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						Total Costs	FY01	FY02	FY03	FY04	
2	3	5.3.8	Protect grass & shrubland communities on southwestern Valley edge from McKittrick to Maricopa & eastward & northward to Kern River, east of Bakersfield	ongoing	USBLM/ USFWS/ CDFG/ CDWR/ others	TBD					Depends on 1.2.2
2	4	3.2.21	Conduct surveys for upland vertebrates in the Kettleman Hills	3 years	USFWS/ USBLM/ CDFG	0.7	0.3	0.2	0.2		
2	4	3.2.32	Conduct surveys for kit fox in the Salinas River & Pajaro River watersheds	3 years	USFWS/CDFG	0.9	0.3	0.3	0.3		
2	4	4.9	Conduct systematics & genetics research on Bakersfield smallscale at Kern Lake	2 years	USFWS/CDFG	0.6	0.4	0.2			
2	4	4.17	Conduct multiple research tasks & monitoring for multiple plant species in the Lost Hills	ongoing	USFWS/ USBLM/ CDFG	2	0.4	0.4	0.4	0.4	Monitoring ongoing; research 5-10 years
2	4	4.20	Conduct research on pesticide effects on pollinators of Bakersfield cactus	3 years	USFWS/CDFA/ CDFG/CEPA/ USBLM	0.65	0.25	0.25	0.15		
2	4	4.21	Conduct multiple research tasks & monitoring for Bakersfield cactus at Wheeler Ridge & other locations in Kern Co.	ongoing	USFWS/ CDWR/CDFG	TBD	5.425	3.725	3.7	3.7	Monitoring ongoing; research 5-10 years
2	4	4.28	Conduct multiple research tasks & monitoring for multiple plant species at Kettleman Hills & Devil's Den	ongoing	USFWS/CDFG/ USBLM	TBD	1.525	1.45	1.45	1.45	Monitoring ongoing; research 5-6 years
2	4	4.31	Conduct multiple research tasks & monitoring for multiple plant & animal species at the Kreyenhagen Hills	ongoing	USFWS/ USBLM/ private	5	1	1	1	1	Monitoring ongoing; research 5 years

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						Total Costs	FY01	FY02	FY03	FY04	
2	4	4.32	Conduct multiple research tasks & monitoring for San Joaquin woolly-threads at Jacalitos Hills	ongoing	USFWS/ USBLM/ private	TBD	0.225	0.15	0.15	0.15	Monitoring ongoing; research 5-10 years
2	4	4.33	Conduct multiple research tasks & monitoring for palmate-bracted bird's-beak & multiple animal species at Alkali Sink ER	ongoing	USFWS/CDFG	10	2	2	2	2	
2	4	4.35	Conduct multiple research tasks & monitoring for multiple plant & animal species in W. Madera Co.	TBD	USFWS/BOR	TBD	0.5	0.5	0.5	0.5	Monitoring ongoing; research 5-10 years
2	4	4.37	Conduct multiple research tasks & monitoring for multiple plant & animal species in the Ciervo-Panoche area	5 years	USFWS/ USBLM/ CDFG	1.5	0.3	0.3	0.3	0.3	
2	4	4.38	Conduct censuses for kit fox & monitoring for multiple animal species in the Ciervo-Panoche area	ongoing	USFWS/ USBLM/ CDFG	TBD	0.3	0.2	0.1	0.1	Monitoring ongoing
2	4	4.42	Census & monitor Lost Hills saltbush population at San Luis Island	ongoing	USFWS	TBD	0.05	0.05	0.05	0.05	Monitoring ongoing
2	4	4.44	Census & monitor kit fox in the NE. & NW. Valley fringes & in the NW. portion of the range	ongoing	USFWS/CDFG	TBD	0.5	0.5	0.5	0.5	Monitoring ongoing
2	4	4.47	Conduct multiple research tasks for palmate-bracted bird's-beak at Springtown	ongoing	USFWS/CDFG/ local/private	TBD	3.3	1.8	1.8	1.8	Monitoring ongoing; research 5-10 years
2	4	4.49	Conduct multiple research tasks & monitoring for palmate-bracted bird's-beak at Woodland & Sacramento NWR complex	ongoing	USFWS	8.77	1.87	1.72	1.72	1.72	Monitoring ongoing; research 5 years

Implementation Schedule for Upland Species, San Joaquin Valley, California. *Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.*

Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
						Total Costs	FY01	FY02	FY03	FY04	
2	4	4.50	Conduct censuses & monitoring of lesser saltscale populations in Butte, Merced, & Kern counties	ongoing	USFWS	TBD	0.2	0.15	0.15	0.15	
2	4	4.52	Conduct metapopulation genetics research on the San Joaquin kit fox	2 years	USFWS/CDFG	0.6	0.4	0.2			
2	4	4.53	Conduct population genetics research on the Buena Vista Lake shrew	2 years	USFWS/private	0.8	0.4	0.4			
2	4	4.60	Census & monitor any populations of Comanche Point layia	TBD	USFWS/CDFG	TBD					
2	4	4.64	Census & monitor any populations of Merced phacelia	TBD	USFWS/CDFG	TBD					
2	4	4.65	Census & monitor any populations of Munz's tidy-tips	TBD	USFWS/CDFG	TBD					
2	4	4.66	Census & monitor any populations of Tejon poppy	TBD	USFWS/CDFG	TBD					
2	4	4.82	Research the effects of selenium on Buena Vista Lake shrews	5 years	USFWS/CDFG/CEPA	1.5	0.3	0.3	0.3	0.3	
2	4	5.1.2	Establish linkage along Garces Hwy Corridor for multiple animal species	TBD	USFWS/CDFG/local/private	TBD					Depends on 1.2.2 and 1.2.6
2	4	5.1.8	Establish linkage between northwestern & northeastern Valley edges through the Sandy Mush Road area	TBD	USFWS/CDFG/local/private	TBD					Depends on 1.2.2
2	4	5.3.2	Protect San Joaquin kit fox habitat in northwestern San Joaquin Valley edge	ongoing	USFWS/CDFG/local/private	TBD					Depends on 1.2.2

Implementation Schedule for Upland Species, San Joaquin Valley, California. Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.

Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
						Total Costs	FY01	FY02	FY03	FY04	
2	4	5.3.3	Protect grassland & oak savanna on east & southeastern edge of Valley for several listed species	ongoing	USFWS/CDFG/ local/private	TBD					Depends on 1.2.2
2	4	5.3.4	Protect grass & shrubland communities on western Valley edge, Santa Nella to Panoche Creek	TBD	USFWS/CDFG/ USBLM	TBD					Depends partly on 1.2.2
2	4	5.3.5	Protect grass & shrubland communities on western Valley edge, Panoche Creek to Ciervo Wash	TBD	USFWS/CDFG/ USBLM	TBD					Depends on 1.2.2
2	4	5.3.6	Protect grass & shrubland communities on western Valley edge, Ciervo Wash to Coalinga	TBD	USFWS/CDFG/ USBLM/local	TBD					Depends on 1.2.2
2	4	5.3.7	Protect grass & shrubland communities on western Valley edge, Coalinga to McKittrick	TBD	USFWS/CDFG/ USBLM/local	TBD					Depends on 1.2.2
2	4	7.3	Reintroduce Comanche Point layia in appropriate habitat as necessary	TBD	USFWS/CDFG	TBD					
2	4	7.4	Propagate California jewelflower in greenhouses & reintroduce to appropriate habitat as necessary	TBD	USFWS/CDFG	TBD	0.30	0.25			Propagation costs
2	4	7.5	Propagate Vasek's clarkia in greenhouses & reintroduce to appropriate habitat as necessary	TBD	USFWS/CDFG	TBD	0.30	0.25			Propagation costs
2	5	4.18	Conduct multiple research tasks & monitoring on Bakersfield cactus at Kern Bluffs & other locations in Kern Co.	ongoing	USFWS/CDFG/ local/private	TBD	4.8	3.825	3.6	3.6	Monitoring ongoing; research 5-10 years
2	5	4.69	Study effects of beet leafhopper control on beetle species	3 years	CDFA/ CDFG/CEPA	1	0.4	0.3	0.3		

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Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimates (in $100,000 units)					Comments/Notes
						Total Costs	FY01	FY02	FY03	FY04	
3	1	2.1.13	Protect natural lands & traditional rangeland uses in the Upper Cuyama Valley	ongoing	USFS/ USBLM/ USFWS	TBD					Depends on 1.2.2
3	1	2.1.16	Protect & properly manage listed species habitat at Bitter Creek NWR	ongoing	USFWS	TBD					
3	1	2.1.18	Protect & properly manage listed species habitat at Mendota WA	ongoing	CDFG	TBD					
3	1	4.80	Refine metapopulation viability analysis for the kit fox	3 years	USFWS/CDFG	0.9	0.3	0.3	0.3		Requires census and demography data not yet available
3	1	5.1.9	Establish & enhance linkage between Kern NWR & Sierran foothills through the Poso Creek area	ongoing	USFWS/COE/ USBLM/local/ private	TBD					
3	1	8.1	Conduct status review of lesser saltscale	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	1	8.2	Conduct status review of Bakersfield smallscale	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	1	8.4	Conduct status review of Vasek's clarkia	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	1	8.7	Conduct status review of diamond-petaled California poppy	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	1	8.8	Conduct status review of Comanche Point layia	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	1	8.11	Conduct status review of Merced monardella	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	1	8.13	Conduct status review of oil neststraw	1 year	USFWS	0.1	0.1				Depends on surveys and censuses

Implementation Schedule for Upland Species, San Joaquin Valley, California. Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.

Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimates (in [illegible] units)					Comments/Notes
						Total Costs	[illegible]	[illegible]	[illegible]	[illegible]	
3	1	8.16	Conduct status review of Doyen's dune weevil	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	1	8.17	Conduct status review of San Joaquin antelope squirrel	1 year	USFWS/CDFG	0.1	0.1				Depends on surveys and censuses
3	1	8.18	Conduct status review of short-nosed kangaroo rat	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	1	8.20	Conduct status review of Buena Vista Lake shrew	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	2	3.2.17	Conduct surveys for sand dune beetles in sand & sand dune communities of the northwestern Valley	3 years	USFWS/ USBLM	0.75	0.25	0.25	0.25		
3	2	3.2.19	Conduct surveys for upland vertebrates on the southern Valley floor	3 years	USFWS/ CDFG/ USBLM	0.9	0.3	0.3	0.3		
3	2	3.2.20	Conduct surveys for upland vertebrates on the central western Valley edge	3 years	USFWS/ CDFG/ USBLM	0.6	0.2	0.2	0.2		
3	2	3.2.22	Conduct surveys for upland vertebrates on the southwestern Valley edge	3 years	USFWS/ CDFG/ USBLM/DOE	0.9	0.3	0.3	0.3		
3	2	3.2.23	Conduct surveys for upland vertebrates on the southeast & southern Valley edge	3 years	FWS/CDFG/ BLM	0.6	0.2	0.2	0.2		
3	2	3.2.24	Conduct surveys for upland vertebrates in the Cuyama Valley	3 years	USFS/FWS/ CDFG/BLM	0.6	0.2	0.2	0.2		
3	2	3.2.25	Conduct surveys for upland vertebrates in the San Juan Creek watershed	3 years	USFWS/USDA/ USBLM	0.9	0.3	0.3	0.3		Includes USDA easement lands

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Implementation Schedule for Upland Species, San Joaquin Valley, California. Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.

Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimates (in $100,000 units)					Comments/Notes
						Total Costs	FY01	FY02	FY03	FY04	
3	2	3.2.27	Conduct surveys for kit fox in the northwestern portion of range & northwestern Valley edge	3 years	USFWS/CDFG	0.9	0.3	0.3	0.3		
3	2	3.2.28	Conduct surveys for kit fox on the northeastern Valley edge	3 years	USFWS/BOR/CDFG	0.9	0.3	0.3	0.3		
3	2	3.2.29	Conduct surveys for kit fox in the Ciervo-Panoche Natural Area	3 years	USFWS/USBLM/CDFG	0.9	0.3	0.3	0.3		Year 1 already accomplished
3	2	3.2.31	Conduct surveys for kit fox on the southeastern Valley edge	3 years	USFWS/CDFG/BOR	1.0	0.4	0.3	0.3		
3	2	4.2	Conduct censuses for short-nosed kangaroo rats & monitor populations of multiple animal species in the Cuyama Valley	ongoing	USFWS/USBLM/USFS/private	0.3	0.1	0.1	0.1		Census for 3 years; monitoring ongoing
3	2	4.6	Conduct research on mating & social systems of the giant kangaroo rat at the Carrizo Plain	2 years	USFWS/CDFG/USBLM	0.6	0.3	0.3			
3	2	4.22	Monitor populations of multiple plant & animal species at Wheeler Ridge & Comanche Point	ongoing	USFWS/CDFG/CDWR	TBD	0.1	0.1	0.1	0.1	
3	2	4.29	Monitor populations of multiple animal species at the Kettleman Hills	ongoing	USFWS/USBLM/CDFG/CDWR	TBD	0.1	0.1	0.1	0.1	
3	2	4.39	Conduct systematics research on Lost Hills saltbush	2 years	USFWS/USBLM/CDFG	0.5	0.25	0.25			
3	2	4.40	Conduct systematics research on Merced phacelia	2 years	USFWS/CDFG/COE	0.5	0.25	0.25			
3	2	4.41	Conduct systematics research on Temblor buckwheat	2 years	USFWS/USBLM/CDFG	0.5	0.25	0.25			

Implementation Schedule for Upland Species, San Joaquin Valley, California. Task Numbers are those of Section IV. Within a Priority Tier, tasks are of approximately equal priority. Priority Numbers are the priorities defined in Section III.

Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
						Total Costs	FY98	FY99	FY00	FY01	
3	2	4.51	Conduct metapopulations genetics research on the blunt-nosed leopard lizard	2 years	USFWS/CDFG	0.8	0.4	0.4			
3	2	4.58	Conduct research on the direct & indirect effects of rodenticides on kit fox	5 years	CDFA/CEPA/ USFWS/CDFG	10	2	2	2	2	
3	2	4.68	Study the effects of salinity on the structure of Bakersfield smallscale	2 years	USFWS/CDFG	0.4	0.2	0.2			
3	2	4.71	Conduct matrix projection modeling for California jewelflower	1 year	USFWS	0.15	0.15				
3	2	4.72	Conduct matrix projection modeling for palmate-bracted bird's-beak	1 year	USFWS	0.15	0.15				
3	2	4.73	Conduct matrix projection modeling for Kern mallow	1 year	USFWS	0.15	0.15				
3	2	4.74	Conduct matrix projection modeling for San Joaquin woolly-threads	1 year	USFWS	0.15	0.15				
3	2	4.75	Conduct matrix projection modeling for Bakersfield cactus	1 year	USFWS	0.15	0.15				
3	2	4.76	Conduct a single-metapopulation viability analysis on the giant kangaroo rat	1 year	USFWS/DOE/ USBLM/CDFG	0.3	0.3				
3	2	4.77	Conduct a single-metapopulation viability analysis on the Fresno kangaroo rat	1 year	USFWS/CDFG/ USN	0.3	0.3				
3	2	4.78	Conduct a single-metapopulation viability analysis on the Tipton kangaroo rat	1 year	USFWS/CDFG	0.2	0.2				Assumes analyses of Tipton & Fresno subspecies done together

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Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
						Total Costs	FY01	FY02	FY03	FY04	
3	2	4.79	Conduct a single-metapopulation viability analysis on the blunt-nosed leopard lizard	1 year	USFWS/CDFG	0.3	0.3				
3	2	5.1.6	Enhance & manage Kern River alluvial fan area to ensure use & movement by kit foxes & Tipton kangaroo rats	ongoing	USFWS/CDFG/ KWBA/KCWA/ local	TBD	2.5	2.5	1.0	0.25	
3	2	5.3.10	Maintain & enhance habitat linkages for upland species between CPNA & Cuyama Valley	ongoing	USBLM/ USFWS/ CDFG	TBD	0.1	0.1	0.1	0.1	
3	2	5.3.11	Maintain habitat linkage for upland species in the Estrella River watershed	ongoing	USFWS/CDFG/ local/private	TBD					Depends partly on 1.2.2
3	2	5.3.12	Maintain & enhance habitat linkages for upland species in the San Juan Creek watershed, San Luis Obispo Co.	ongoing	USFWS/USDA/ CDFG/local/ private	TBD					Depends partly on 1.2.2
3	3	2.1.8	Protect Federal wildlife refuges & waterfowl easement properties, State wildlife areas & State park land, NW. Merced Co.	ongoing	USFWS	TBD					
3	3	2.1.11	Protect natural land in Kern NWR-Semitropic Ridge Natural Area	ongoing	USFWS/CDFG/ CEC/TNC/ private	TBD					Depends partly on 1.2.2 and 1.2.6
3	3	4.70	Publish scientific name & description of Doyen's dune weevil	TBD	private	0.25	0.25				Costs (page) of scientific publication
3	3	5.1.3	Protect & restore habitat & habitat linkages along Hwy 43 Corridor for Tipton kangaroo rat, blunt-nosed leopard lizard, San Joaquin kit fox, & other species	ongoing	USFWS/CDFG/ local	TBD					Depends partly on 1.2.2 and 1.2.6

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Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $000,000 units)					Comments/Notes
						Total Costs	[illegible]	[illegible]	[illegible]	[illegible]	
3	3	5.1.4	Protect & restore habitat & habitat linkages for San Joaquin kit foxes between Lost Hills & Semitropic Ridge	ongoing	USFWS/CDFG/ local	TBD					Depends partly on 1.2.2 and 1.2.6
3	3	7.1	Reintroduce Doyen's dune weevil to appropriate habitat if necessary	5 years	USFWS/CDFG/ USBLM	TBD	0.3	0.15	0.15	0.15	Monitor reintroduction for at least 5 years
3	4	4.23	Conduct systematics & genetics research at all inhabited sites of Bakersfield cactus	2 years	USFWS	0.65	0.35	0.3			
3	4	5.2	Reintroduce featured species to restored habitat within linkages	TBD	USFWS/CDFG/ USBLM	TBD					
3	4	5.3.1	Protect San Joaquin kit fox habitat in northeastern San Joaquin Valley edge	ongoing	USFWS/CDFG/ local/private	TBD					Depends on 1.2.2
3	4	6	Revise or develop new management plans for protected areas	TBD	TBD	TBD					
3	4	8.3	Conduct status review of Lost Hills saltbush	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	4	8.5	Conduct status review of Temblor buckwheat	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	4	8.6	Conduct status review of Tejon poppy	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	4	8.9	Conduct status review of Munz's tidy- tips	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	4	8.10	Conduct status review of Jared's peppergrass	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	4	8.12	Conduct status review of Merced phacelia	1 year	USFWS	0.1	0.1				Depends on surveys and censuses

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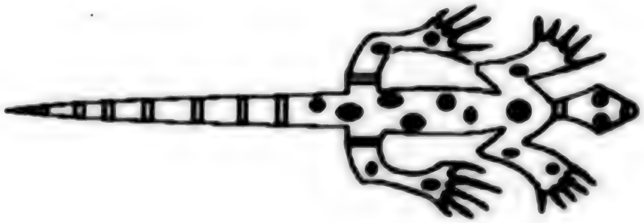
Priority Number	Priority Tier	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimates (in $100,000 units)					Comments/Notes
						Total Costs	FY01	FY02	FY03	FY04	
3	4	8.14	Conduct status review of Ciervo aegialian scarab beetle	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	4	8.15	Conduct status review of San Joaquin dune beetle	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	4	8.19	Conduct status review of Tulare grasshopper mouse	1 year	USFWS	0.1	0.1				Depends on surveys and censuses
3	4	8.21	Conduct status review of San Joaquin LeConte's thrasher	1 year	USFWS	0.1	0.1				Depends on surveys and censuses



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VII. APPENDIX

A. List of Scientific and Common Names of Plants and Animals

[illegible]	[illegible]
PLANTS	
Alkali daisy	*Lasthenia ferrisiae*
Alkali heath	*Frankenia salina*
Alkali peppergrass	*Lepidium dictyotum*
Alkali sacaton	*Sporobolus airoides*
Anderson desert thorn	*Lycium andersonii*
Annual fescue	*Vulpia microstachys*
Arabian grass	*Schismus arabicus*
Arabian grass species	*Schismus* spp.
Arrowscale	*Atriplex phyllostegia*
Bakersfield cactus	*Opuntia basilaris* var. *treleasei*
Bakersfield smallscale	*Atriplex tularensis*
Baltic rush	*Juncus balticus*
Beavertail cactus	*Opuntia basilaris*
Big saltbush	*Atriplex lentiformis*
Bladderpod	*Isomeris arborea*
Booth's evening primrose	*Camissonia boothii*
Bractscale	*Atriplex serenana*
Brittlescale	*Atriplex depressa*
California blackberry	*Rubus ursinus*
California buckwheat	*Eriogonum fasciculatum*
California ephedra	*Ephedra californica*
California filago	*Filago californica*
California jewelflower	*Caulanthus californicus*
California juniper	*Juniperus californica*
California poppy	*Eschscholzia californica*
California wild rose	*Rosa californica*
Carrizo peppergrass	*Lepidium jaredii* ssp. *jaredii*
Chaparral yucca	*Yucca whipplei*
Cheesebush	*Hymenoclea salsola*
Chinese lantern phacelia	*Phacelia ciliata*
Clover species	*Trifolium* spp.
Comanche Point layia	*Layia leucopappa*
Common saltbush	*Atriplex polycarpa*
Common spikeweed	*Hemizonia pungens*
Common tidy-tips	*Layia platyglossa*
Coulter's jewelflower	*Caulanthus coulteri*
Coyote bush	*Baccharis* sp.
Coyote-mint	*Monardella villosa*
Crownscale	*Atriplex coronata*
Desert mallow	*Eremalche exilis*

A. *List of Scientific and Common Names of Plants and Animals (continued)*

Common Name	Scientific Name
Diamond-petaled California poppy	*Eschscholzia rhombipetala*
Douglas' coyote bush	*Baccharis douglasii*
Eastwoodia	*Eastwoodia elegans*
Eastwood's buckwheat	*Eriogonum eastwoodianum*
Everlasting neststraw	*Stylocline gnaphaloides*
Ephedra	*Ephedra spp.*
Farewell-to-spring	*Clarkia cylindrica*
Fiddleneck	*Amsinckia spp.*
Filaree	*Erodium spp.*
Fremont poplar	*Populus fremontii*
Frying pans	*Eschscholzia lobbii*
Glasswort	*Salicornia subterminalis*
Goldenbush	*Ericameria, Haplopappus, and Isocoma spp.*
Goldfields	*Lasthenia californica*
Greasewood	*Sarcobatus vermiculatus*
Green clover	*Trifolium wormskioldii*
Green ephedra	*Ephedra viridis*
Gunsight clarkia	*Clarkia unguiculata*
Haplopappus species	*Haplopappus spp.*
Heartscale	*Atriplex coronata*
Hillside daisy	*Monolopia lanceolata*
Hispid bird's beak	*Cordylanthus mollis ssp. hispidus*
Hollisteria	*Hollisteria lanata*
Honey mesquite	*Prosopis glandulosa var. torreyana*
Hoover's woolly-star	*Eriastrum hooveri*
Idria buckwheat	*Eriogonum vestitum*
Iodine bush	*Allenrolfea occidentalis*
Jared's peppergrass	*Lepidium jaredii*
Jones' tidy-tips	*Layia jonesii*
Kern mallow	*Eremalche kernensis*
Large-leaved filaree	*Erodium macrophyllum*
Leafy-stemmed coreopsis	*Coreopsis calliopsidea*
Lemmon's poppy	*Eschscholzia lemmonii ssp. lemmonii*
Lesser saltscale	*Atriplex minuscula*
Lost Hills saltbush	*Atriplex vallicola*
Many-flowered eriastrum	*Eriastrum pluriflorum*
Marsh baccharis	*Baccharis douglasii*
Matchweed	*Gutierrezia californica*
Merced monardella	*Monardella leucocephala*
Merced phacelia	*Phacelia ciliata var. opaca*
Microseris	*Microseris douglasii*
Mouse-tail fescue	*Vulpia myuros*

A. *List of Scientific and Common Names of Plants and Animals (continued)*

Mulefat	*Baccharis salicifolia*
Munz's tidy-tips	*Layia munzii*
Narrowleaf goldenbush	*Ericameria linearifolia*
Oil neststraw	*Stylocline citroleum*
One-sided bluegrass	*Poa secunda* ssp. *secunda*
Pacific blackberry	*Rubus vitifolius*
Pale-leaf goldenbush	*Isocoma acradenia* var. *bracteosa*
Palmate-bracted bird's beak	*Cordylanthus palmatus*
Panoche peppergrass	*Lepidium jaredii* ssp. *album*
Parish's brittlescale	*Atriplex parishii*
Parry's mallow	*Eremalche parryi* ssp. *parryi*
Parry's saltbush	*Atriplex parryi*
Peppergrass	*Lepidium nitidum*
Pickleweed	*Salicornia subterminalis*
Pine bluegrass	*Poa secunda*
Purple needlegrass	*Nassella pulchra*
Quailbush	*Atriplex lentiformis*
Red brome	*Bromus madritensis* ssp. *rubens*
Red maids	*Calandrinia ciliata*
Red-stemmed filaree	*Erodium cicutarium*
Ripgut brome	*Bromus diandrus*
Saltbush	*Atriplex* spp.
Salt grass	*Distichlis spicata*
San Benito thornmint	*Acanthomintha obovata*
San Joaquin woolly-threads	*Lembertia congdonii*
Scalebroom	*Lepidospartum* sp.
Scratchgrass	*Muhlenbergia asperifolia*
Seepweed	*Suaeda moquinii*
Shadscale	*Atriplex confertifolia*
Shepherd's purse	*Capsella bursa-pastoris*
Sierra monardella	*Monardella candicans*
Slender wild oats	*Avena barbata*
Snowy eatonella	*Eatonella nivea*
Soft chess	*Bromus hordeaceus*
Spiny saltbush	*Atriplex spinifera*
Springville clarkia	*Clarkia springvillensis*
Sun cups	*Camissonia californica*
Tejon poppy	*Eschscholzia lemmonii* ssp. *kernensis*
Temblor buckwheat	*Eriogonum temblorense*
Temblor clarkia	*Clarkia tembloriensis*
Tufted poppy	*Eschscholzia caespitosa*
Vasek's clarkia	*Clarkia tembloriensis* ssp. *calientensis*

A. *List of Scientific and Common Names of Plants and Animals (continued)*

White Sierran layia	*Layia pentachaeta* ssp. *albida*
Wild barley	*Hordeum* sp.
Wild grape	*Vitis californica*
Wild oats	*Avena fatua*
Wild-rye	*Elymus* sp.
Willow species	*Salix* spp.
Wind poppy	*Stylomecon heterophylla*
Winterfat	*Krascheninnikovia lanata*
Woolly goldfields	*Lasthenia minor*
Yellow pincushion	*Chaenactis glabriuscula*

ANIMALS

American badger	*Taxidea taxus*
American kestrel	*Falco sparverius*
American opossum	*Marsupialia virginiana*
Barn owl	*Tyto alba*
Beeflies	Bombyliidae
Bendire's thrasher	*Toxostoma bendirei*
Black-tailed hare	*Lepus californicus*
Blunt-nosed leopard lizard	*Gambelia sila*
Bobcat	*Felis rufa*
Buena Vista Lake shrew	*Sorex ornatus relictus*
Bumblebee	*Bombus californicus*
Bumblebee	*Bombus occidentalis*
Bumblebee	*Bombus vosnesenskii*
Burrowing owl	*Athene cunicularia*
California condor	*Gymnogyps californianus*
California ground squirrel	*Spermophilus beecheyi*
California pocket mouse	*Chaetodipus californicus*
California thrasher	*Toxostoma redivivum*
California whiptail	*Cnemidophorus tigris*
Chukar	*Alectoris chukar*
Ciervo aegialian scarab beetle	*Aegialia concina*
Coachwhip	*Masticophis flagellum*
Coast horned lizard	*Phrynosoma coronatum*
Common king snake	*Lampropeltis getulus*
Coyote	*Canis latrans*
Crissal thrasher	*Toxostoma dorsale*
Deer mouse	*Peromyscus maniculatus*
Desert cottontail	*Sylvilagus audubonii*
Desert thrasher	*Toxostoma lecontei arenicola*
Domestic dog	*Canis familiaris*

A. List of Scientific and Common Names of Plants and Animals (continued)

Doyen's dune weevil	*Trigonoscuta sp.*
Dusky-footed woodrat	*Neotoma fuscipes*
Feral cat	*Felis sylvestris*
Fresno kangaroo rat	*Dipodomys nitratoides exilis*
Giant garter snake	*Thamnophis gigas*
Giant kangaroo rat	*Dipodomys ingens*
Glossy snake	*Arizona elegans*
Golden eagle	*Aquila chrysaetos*
Gopher snake	*Pituophis melanoleucus*
Gray fox	*Urocyon cinereoargenteus*
Great-horned owl	*Bubo virginianus*
Greater roadrunner	*Geococcyx californianus*
Heermann's kangaroo rat	*Dipodomys heermanni*
Honey bee	*Apis mellifera*
House mouse	*Mus musculus*
Le Conte's thrasher	*Toxostoma lecontei*
Loggerhead shrike	*Lanius ludovicianus*
Long-nosed leopard lizard	*Gambelia wislizenii*
Long-tailed weasel	*Mustela frenata*
McKittrick pocket mouse	*Perognathus inornatus neglectus*
Merriam's kangaroo rat	*Dipodomys merriami*
Mountain plover	*Charadrius montanus*
Native bees	Apoidae
Northern mockingbird	*Mimulus polyglottus*
Ornate shrew	*Sorex ornatus*
Red-shouldered hawk	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
Red fox	*Vulpes vulpes*
Riparian brush rabbit	*Sylvilagus bachmani riparius*
Riparian woodrat	*Neotoma fuscipes riparius*
Roof rat	*Rattus rattus*
Sage thrasher	*Oreoscoptes montanus*
Salt marsh harvest mouse	*Reithrodontomys raviventris*
San Joaquin antelope squirrel	*Ammospermophilus nelsoni*
San Joaquin dune beetle	*Coelus gracilis*
San Joaquin kangaroo rat	*Dipodomys nitratoides*
San Joaquin kit fox	*Vulpes macrotis mutica*
San Joaquin Le Conte's thrasher	*Toxostoma lecontei lecontei*
San Joaquin pocket mouse	*Perognathus inornatus*
Short-eared owl	*Asio flammeus*
Short-nosed kangaroo rat	*Dipodomys nitratoides brevinasus*
Side-blotched lizard	*Uta stansburiana*
Solitary bee	*Diadasia australis ssp. californica*

A. *List of Scientific and Common Names of Plants and Animals (continued)*

Common Name	[illegible]
Solitary bee	*Diadasia laticauda*
Solitary bees	*Synhalonia spp.*
Southern grasshopper mouse	*Onychomys torridus*
Spiny lizard species	*Scelporus spp.*
Spotted skunk	*Spilogale gracilis*
Stephen's woodrat	*Neotoma stephensi*
Striped skunk	*Mephitis mephitis*
Suisun shrew	*Sorex ornatus sinuosus*
Swainson's hawk	*Buteo swainsoni*
Swift fox	*Vulpes velox*
Tipton kangaroo rat	*Dipodomys nitratoides nitratoides*
Tulare grasshopper mouse	*Onychomys torridus tularensis*
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*
Western gray squirrel	*Sciurus occidentalis*
Western harvest mouse	*Reithrodontomys megalotis*
Western long-nosed snake	*Rhinocheilus lecontei*
Western rattlesnake	*Crotalis virdis*
White-footed mouse species	*Peromyscus spp.*

B. GLOSSARY OF TECHNICAL TERMS

[illegible]	[illegible]
achene	a tiny dry fruit with one seed
adaptive management	a long-term repeated process of gradually modifying management techniques based upon the results of modeling and research
alkali scald	barren area with a surface crust of salts
alkali sink	drainage basin with soil high in soluble salts
alluvial fan	fan-shaped area of soil deposited where a mountain stream first enters a valley or plain
apomixis	seed set without fertilization
arid	dry
auditory bullae	boney capsules containing the middle and inner ears
biological niche	all the physical and biological factors required for a particular species to live and its way of living
biosystematic study	research that uses evidence from several disciplines to determine the appropriate taxonomic placement and relationship to other species.
bisexual	having both male and female parts (said of a flower)
bract	a leaf-like structure that is associated with a flower; may be green or colored
brummate	dormancy in animals whose body temperature varies with their environment
Caltrans	California Department of Transportation
calyx	the group of leaf-like structures (sepals) in a flower immediately below the petals
CDFG	California Department of Fish & Game
chenopod	a plant in the goosefoot family (Chenopodiaceae)
Ciervo-Panoche Natural Area	natural lands along the western edge of the Valley and in the contiguous foothills and coastal range, from the Panoche Hills and Valley, Fresno and San Benito Counties, south to Anticline Ridge near Coalinga, Fresno County
ciliate	having stiff hairs along the margin
cismontane	west of the Sierra Nevada crest (literally on this side of the mountains)
clumps	groups of cactus pads that are rooted at the same point
COE	Army Corps of Engineers
corolla	the set of petals in a flower whether separate or fused

B. *Glossary of Technical Terms (continued)*

crissum	undertail feathers
cryptogamic crust	a layer of moss, lichen, and algae on the soil surface
disk florets	tiny tubular flowers that are clustered in the center of a flower head, like a common daisy
demography, demographic	the study of populations with reference to birth and death rates, size and density, distribution, migration, and other vital statistics
ear pinnae	external ear flaps
effective dispersal	dispersal of genes
Endangered Species Recovery Program	a cooperative research program on biodiversity conservation in central California, administered by California State University, Stanislaus Foundation
endemic, endemism	restricted in occurrence to a stated site or area (e.g., endemic to California)
entire	untoothed or smooth (said of the margin of a leaf)
estrus	periodic physiological state in female mammals that immediately precedes ovulation; heat
extant	still in existence
eye-spots	rounded structures on cactus pads that contain barbed bristles
florets	tiny flowers characteristic of the aster family
forb	broad-leaved herb
guild	meaning a group of species with a common need for a particular habitat or other niche component
gular	throat area
gynodioecy	a state of certain plant populations characterized by a mixture of plants with flowers having only female parts and plants with flowers having both male and female parts (adjective: gynodioecious)
habitat protection	ensuring appropriate uses of land to maintain and optimize species habitat values
halophyte	plant tolerant of alkaline and saline soils
hemiparasitic	obtaining water and nutrients from the roots of other plants then manufacturing food through photosynthesis (noun: hemiparasitism)
host plant	the source of water and nutrients for a parasitic plant
hydrologic regime	seasonal water cycles and movements

B. *Glossary of Technical Terms (continued)*

Term	Definition
keystone species	species that have key roles in shaping the environment that affects the presence or absence of other organisms; usually the presence of a keystone species leads to a greater variety of species
leaf axil	the point where a leaf is attached to a stem
lips	groups of fused petals that differ in appearance
lobes	free tips of flower or leaf parts that are fused at the base
matrilineal	tracing ancestral descent through the maternal line
matrix projection modelling	a mathematical technique that uses life history data to identify critical stages in the life cycle of an organism and project population growth rates (Menges 1986, Schemske et. al. 1994)
metapopulation	scattered groups of plants or animals that may function as a single population due to occasional interbreeding
microhabitat	localized areas with unique conditions due to small-scale variations in physical features of the landscape
mitigation bank	large blocks of land preserved, restored, and enhanced for purposes of consolidating mitigation for and mitigating in advance for projects that take listed species
mosaic	interspersed patches of vegetation each dominated by a different species
occurrences	collection sites separated by 0.4 kilometers (0.25 miles) or more
pad	the fleshy flattened green stem of a cactus
palmate	deeply divided into finger-like segments (usually in reference to leaf shape)
phenology	timing of different stages in the life cycle of a plant
pistillate	having only female reproductive parts (said of a flower)
playa	a shallow temporary lake that may form in alkali sinks
poikilothermic	having a body temperature that varies with the temperature of its surroundings (cold-blooded animals)
polygyny	mating pattern in which a male mates with more than one female in a single breeding season
postpartum	soon after giving birth
precinct	area over and around the burrow system of a giant kangaroo rat in which most activity takes place

B. *Glossary of Technical Terms (continued)*

ray florets	tiny flowers with flattened fused petals that occur near the margin of a flower head in a member of the Aster family (e.g., the petals of a common daisy)
Salinas-Pajaro Region	areas of the Salinas River and Pajaro River watersheds with habitat for kit foxes
savanna	a combination of grassland and woodland in which the trees are widely scattered
scrub	shrubland dominated by shrubs less than 2 meters (6 feet) tall
stamen	the male reproductive part of a plant
style	part of the female reproductive system of a plant
superciliary stripe	a stripe above the eye
taxon	a taxonomic unit of any rank, often used to refer to an entity that is considered by some to be a subspecies and others to be a species (plural: taxa)
tubercle	a wart-like projection
type specimen	the individual plant or animal that was the basis for the original description of a scientific name
type locality	the site from which a type specimen was collected
umbrella species	a species that lives in many biotic communities or has broad habitat requirements that if provided for and protected will protect the habitat of many other species
unicuspids	teeth behind the incisors that have a single main chewing surface (cusp)
vegetative reproduction	the production of new plants from sources other than seed (e.g., from cuttings or root runners)
USBLM	U.S. Bureau of Land Management
USFWS	U.S. Fish & Wildlife Service
western Kern County	Elk Hills, Buena Vista Valley, Buena Vista Hills, Lokern Natural Area, and adjacent natural lands

C. PRIORITIES FOR RECOVERY OF THREATENED AND ENDANGERED SPECIES
FEDERAL REGISTER 48(221):519

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict*
High	High	Monotypic Genus	1	1C
				1
	High	Species	2	2C
				2
	High	Subspecies	3	3C
				3
	Low	Monotypic Genus	4	4C
				4
	Low	Species	5	5C
				5
	Low	Subspecies	6	6C
				6
Moderate	High	Monotypic Genus	7	7C
				7
	High	Species	8	8C
				8
	High	Subspecies	9	9C
				9
	Low	Monotypic Genus	10	10C
				10
	Low	Species	11	11C
				11
	Low	Subspecies	12	12C
				12
Low	High	Monotypic Genus	13	13C
				13
	High	Species	14	14C
				14
	High	Subspecies	15	15C
				15
	Low	Monotypic Genus	16	16C
				16
	Low	Species	17	17C
				17
	Low	Subspecies	18	18C
				18

* C=Conflict with human activities.

D. LISTED AND CANDIDATE SPECIES OCCURRING IN THE SAN JOAQUIN VALLEY REGION WHICH ARE NOT FEATURED IN THIS RECOVERY PLAN. *CT = State listed as threatened, CE = State listed as endangered, CR = state listed as rare, FC = Federal candidate, PE= Federal proposed as endangered, PT = Federal proposed as threatened, FE = Federal listed as endangered, FT = Federal listed as threatened.*

Species	Status		Recovery Plan	Distribution and Habitat ¹
	CA	USA		
large-flowered fiddleneck *(Amsinckia grandiflora)*	CE	FE	Yes	NW. SJV; Cismontane woodland, Valley and foothill grasslands
Kaweah brodiaea *(Brodiaea insignis)*	CE	None	No	Tulare County; Cismontane woodland, Valley and foothill grassland / granitic or clay
Chinese Camp brodiaea *(Brodiaea pallida)*	CE	PE	No	Tuolumne County; Valley and foothill grassland (vernal streambeds, serpentinite)
succulent owl's-clover *(Castilleja campestris* ssp. *succulenta)*	CE	PT	In Progress	N. SJV; Vernal pools
Hoover's spurge *(Chamaesyce hooveri)*	None	PT	In Progress	N. SJV, SV; Vernal pools
Springville clarkia *(Clarkia springvillensis)*	CE	PT	No	Tulare County; Chaparral, Cismontane woodland, Valley and foothill grassland
Delta button-celery *(Eryngium racemosum)*	CE	None	No	N. SJV; Riparian scrub (vernally mesic clay depressions)
Contra Costa wallflower *(Erysimum capitatum* ssp. *angustatum)*	CE	FE	Yes	Antioch Dunes, NW. SJV; stabilized riverine dunes / sand and clay
striped adobe-lily *(Fritillaria striata)*	CT	PT	No	S. SJV; Cismontane woodland, Valley and foothill grassland / adobe
Contra Costa goldfields *(Lasthenia conjugens)*	None	PE	In Progress	N. Coast, S. SV, N. SJV, San Francisco Bay, N. Salinas Valley, S. Coast; Valley grassland, vernal pools
Mason's lilaeopsis *(Lilaeopsis masonii)*	CR	None	No	Delta Region, S. SV, N. SJV; tidally-inundated freshwater and brackish water marshes
Antioch Dunes evening-primrose *(Oenothera deltoides* ssp. *howellii)*	CE	FE	Yes	Antioch Dunes, NW. SJV; stabilized riverine dunes / sand and clay
San Joaquin Valley Orcutt grass *(Orcuttia inaequalis)*	CE	PT	In Progress	SJV; Vernal pools
hairy Orcutt grass *(Orcuttia pilosa)*	CE	PE	In Progress	N. SJV, SV; Vernal pools
Hartweg's golden sunburst *(Pseudobahia bahiifolia)*	CE	PE	No	North-central SJV, S. SV; Cismontane woodland, Valley and foothill grassland / clay
San Joaquin adobe sunburst *(Pseudobahia peirsonii)*	CE	PT	No	South-central SJV; Cismontane woodland, Valley and foothill grassland

D. ***Listed and Candidate Species Occurring in the San Joaquin Valley Region Which are Not Featured in this Recovery Plan (continued). CT = State listed as threatened, CE = State listed as endangered, CR = State listed as rare, FC = Federal candidate, PE = Federal proposed as endangered, PT = Federal proposed as threatened, FE = Federal listed as endangered, FT = Federal listed as threatened.***

Species	**Status**		**Recovery Plan**	**Distribution and Habitat** [1]
	CA	**USA**		
Keck's checker-mallow *(Sidalcea keckii)*	None	PE	No	Central SJV; Cismontane woodland, Valley and foothill grassland
Green's tuctoria *(Tuctoria greenei)*	CR	FE	In Progress	SJV, SV; Vernal pools
California vervain *(Verbena californica)*	CT	PT	No	Tuolumne County; Cismontane woodland, Valley and foothill grassland
Crustaceans				
Conservancy fairy shrimp *(Branchinecta conservatio)*	None	FE	In Progress	SV, N. SJV; Vernal pools in valley grassland
longhorn fairy shrimp *(Branchinecta longiantenna)*	None	FE	In Progress	SJV; Vernal pools in Valley and foothill grassland and Chenopod scrub
vernal pool fairy shrimp *(Branchinecta lynchi)*	None	FT	In Progress	SV, SJV; Vernal pools in Foothill grassland and Chenopod scrub
vernal pool tadpole shrimp *(Lepidurus packardi)*	None	FE	In Progress	SV, N. SJV; Vernal pools in Valley grassland
Insects				
Lange's metalmark butterfly *(Apodemia mormo langei)*	None	FE	Yes	Antioch Dunes, NW. SJV; buckwheat in Valley grasslands / sands
Valley elderberry longhorn beetle *(Desmocerus californicus dimorphus)*	None	FT	Yes	SV, SJV, riparian communities; requires elderberry bushes for larval development
Amphibians				
California tiger salamander *(Ambystoma californiense)*	None	FC	In Progress	N. SJV, S. SV, Bay Area, Central Coast, Central Coastal Ranges; aquatic larval stage in Vernal pools, adults in Valley and foothill grassland, Cismontane woodland, Chaparral, Coastal shrub scrub
California red-legged frog *(Rana aurora draytonii)*	None	FT	In Progress	SV, N. SJV, Coastal Ranges, N., Central, and S. Coast; amphibious in ponds, creeks, marshes, and other freshwater and wetland
Reptiles				
Alameda whipsnake *(Masticophis lateralis euryxanthus)*	None	FT	No	East Bay area in Contra Costa and Alameda Counties; Chaparral, coastal scrub, Valley and foothill grassland; pine/oak woodlands
giant garter snake *(Thamnophis gigas)*	CT	FT	In Progress	SV, SJV; amphibious in freshwater streams, sloughs, and marshes on Valley floor

D. *Listed and Candidate Species Occurring in the San Joaquin Valley Region Which are Not Featured in this Recovery Plan (continued). CT = State listed as threatened, CE = State listed as endangered, CR = State listed as rare, FC = Federal candidate, PE = Federal proposed as endangered, PT = Federal proposed as threatened, FE = Federal listed as endangered, FT = Federal listed as threatened.*

Species	Status		Recovery Plan	Distribution and Habitat [1]
	CA	USA		
			Birds	
Aleutian Canada goose *(Branta canadensis leucopareia)*	None	FT	Yes	SV, N. SJV (winter range); marshes, lakes, ponds, pastures, and croplands on Valley floor
Swainson's hawk *(Buteo swainsoni)*	CT	None	No	CV, Modoc Plateau and scattered desert areas; riparian, certain crops, isolated trees for nesting
mountain plover *(Charadrius montanus)*	None	FC	No	SJV and adjacent lowlands, Imperial Valley, Gulf Coast (wintering grounds); Valley and foothill grassland, Chenopod scrub
western yellow-billed cuckoo *(Coccyzus americanus occidentalis)*	CE	None	No	S. British Columbia to CA and NV and Mexico (breeding season); dense riparian forest and woodlands (breeding habitat)
southwestern willow flycatcher *(Empidonax traillii extimus)*	CE	FE	In Progress	CV and east Slope of Sierra Nevada (breeding range); willow thickets, other shrubby riparian associations.
American peregrine falcon *(Falco peregrinus anatum)*	CE	FE	Yes	S. Canada, U.S.A., N. Mexico (historical breeding range); habitat highly variable, feed mainly on small to medium-sized birds
greater sandhill crane *(Grus canadensis tabida)*	CT	None	No	British Columbia S. and E. to NE. CA, OR, MI (breeding); CA and TX (winter); cultivated fields, marshes, Valley grasslands (winter)
California condor *(Gymnogyps californianus)*	CE	FE	Yes	S. SJV (recent), Transverse Range and adjacent lowlands; range widely; feed on carcasses of large mammals including livestock
bald eagle *(Haliaeetus leucocephalus)*	CE	FT	Yes	Alaska to Mexico (historical range), SJV mostly for wintering; mostly associated with rivers and lakes
California black rail *(Laterallus jamaicensis coturniculus)*	CT	None	In Progress	W. Central lowland CA to N. Baja California (historic); coastal and freshwater marshes
bank swallow *(Riparia riparia)*	CT	None	Yes	CA lowlands, CV (breeding), S. Amer. (winter); nest in holes in steep or vertical river banks / sandy to silt loam soils preferred for digging nests
least Bell's vireo *(Vireo bellii pusillus)*	CE	FE	Yes	Lowlands of S., Central CA (historic; probably extirpated from CV); Deciduous riparian forest with cottonwood and willow composition and thick shrub understory

[1] SJV—San Joaquin Valley; SV—Sacramento Valley; CV—Central Valley

E. SAFE HARBOR PROGRAMS

A Safe Harbor Agreement is a voluntary agreement between one or more private or nonfederal landowners and the USFWS to restore, enhance or maintain habitats for listed species, proposed species, candidates or other species of concern. Under the Agreement, the landowner would be provided assurances that additional land use restrictions as a result of their voluntary conservation actions would not be imposed by the USFWS. If the Agreement provides a net conservation benefit to the covered species and the landowner meets all the terms of the Agreement, the USFWS would authorize the incidental taking of covered species to enable the landowner to return the enrolled lands to agreed upon conditions.

Several variations of a safe harbor program are needed to assist in endangered species recovery in the San Joaquin Valley. A general program is needed Valley-wide to encourage farmers to voluntarily create, maintain, and enhance habitat for wildlife and native plants within the farmland mosaic. This program is needed both to increase the value of farmlands for wildlife and to engender trust between farmers and the regulatory agencies. It could apply to islands of natural lands and retired farmland as well as actively farmed ground. The general program, however, should *not* include enhancement of kit fox habitat unless it is set within an experimental framework with scientifically-acceptable levels of baseline measurements of habitat and populations; careful, frequent quantitative monitoring; and provisions to assess risks of the program in attracting and enhancing numbers of red foxes and their impacts on kit foxes. Different criteria and monitoring requirements (by resource management agencies) are needed on lands that currently support listed species compared to lands with no existing endangered species.

1. Components of a Pilot Safe Harbor Program

A more specific safe harbor program, directed at enhancing kit fox populations within the agricultural-natural lands mosaic on the Valley floor and the movement of foxes between the larger populations both on the floor and around the Valley's edge is needed. This program must begin on a small scale and be set within an experimental framework with scientifically acceptable procedures for measurement or identification of:

a. baseline population numbers and habitat, and changes in population sizes with changes in cultural practices and habitat enhancements;

b. proportion of foraging time in different crops and in crops with different cultural practices;

c. prey numbers associated with different crops and cultural practices;

d. food habits (including types of crop plants eaten);

e. home range size and configuration with identification of landscape features used as movement paths;

f. dispersal movements;

g. population recruitment;

h. denning sites and structure of dens;

i. effects of the program on red foxes, habitat features associated with red foxes, and interactions between red foxes and kit foxes, if any.

The greatest concern is that though this program seems important for kit fox recovery, efforts at enhancing kit fox populations on the Valley floor may actually enhance red fox numbers, which may prey on and displace kit foxes from these areas. Thus, the program has a real, but unknown probability of doing more harm than good for recovery of kit foxes. It should only be implemented as a tightly-controlled scientific experiment.

2. Target Areas for San Joaquin Kit Fox Safe Harbor Program

Areas where safe harbor programs can potentially contribute substantially to recovery of kit foxes are:

a. Farmland and small islands of natural lands along the northwest edge of the San Joaquin Valley from south of Los Banos in Merced County to the Delta region in San Joaquin, Alameda, and Contra Costa Counties;

b. Natural lands supporting grasslands and oak savanna in eastern Stanislaus, Merced, and Madera Counties;

c. Natural land and farmland in Merced County in the area along Sandy Mush Road and farmland linking the natural lands along Sandy Mush Road with the natural lands to the east in southern Merced and Madera Counties;

d. Natural land and farmland along the San Joaquin River and Chowchilla Bypass between the wildlife refuges in Merced County and the natural lands in western Madera County;

e. Farmland in western Fresno County along the major flood channels of ephemeral streams draining the coastal ranges to the San Joaquin River-Fresno Slough in the center of the Valley; and on any retired farmlands in the area that remain in private ownership after retirement;

f. Farmland that is periodically not farmed for more than 2 or 3 years at a time along the western edge of the Valley in Fresno, Kings, and Kern Counties;

g. Farmland and natural lands along the Highway 46 Corridor between natural lands west of Blackwell's Corner, Kern County, and natural lands in the Semitropic Ridge Area;

h. Farmland and natural lands between the Semitropic Ridge Area and the Pixley-Allensworth Natural Area, along the Garces Highway corridor;

i. Farmland and natural lands within the Pixley-Allensworth Natural Area and between this area and Creighton Ranch Preserve to the north;

j. Farmland and natural lands along Poso Creek between natural lands in the Sierra foothills on the east and Kern National Wildlife Refuge on the west;

k. Natural land and farmland along the Estrella River tributaries in San Luis Obispo County;

l. Natural land and farmland elsewhere in the Salinas River watershed in San Luis Obispo and Monterey Counties.

m. Natural land along the Kern River within the Bakersfield metropolitan area and westward.

n. Natural land and farmlands between the Kettleman Hills and Anticline Ridge in Fresno County.

o. Natural land along San Juan Creek from Shandon on the northwest, southeastward along the tributaries of the Creek's watershed, including dryland grain fields in the Conservation Reserve program.

p. San Joaquin Valley foothills with grassland and saltbush scrub communities from western Madera County southward to the southern end of the Valley, then eastward and northward through Tulare County; and on the northeast in eastern Madera, Merced, and Stanislaus Counties.

q. Natural lands in the Cuyama River watershed between about Cottonwood Canyon on the west, eastward and southward to the vicinity of Ballinger and Santa Barbara Canyons, including the lower reaches of the canyons where habitats for featured species are found.

Much of the planning area may eventually be included in safe harbor programs for the San Joaquin kit fox, but a phased approach is recommended. The first phase must be carefully controlled and needs to identify the farmland features and cultural practices that are associated with success in terms of kit fox survival, population recruitment, and dispersal movements, as well as any negative effects from alien red foxes. Later phases should be instituted first in areas identified as being important in promoting connectivity between major kit fox populations and include features identified as of positive value to the program objectives. These would be phased in as landowner participation and funding warrant. At all phases of the program, scientifically acceptable monitoring and analysis should be conducted. This is important to evaluate the efficacy of the programs and their contributions to recovery, and to identify and ward off potential problems such as those associated with red foxes.

F. RETIREMENT OF FARMLAND WITH DRAINAGE PROBLEMS

Retirement of irrigated farmland is one component of the plan to manage the drainage-related problems along the center and western side of the San Joaquin Valley (San Joaquin Valley Drainage Program 1990; HR429, 1992). The State of California also has a retirement program (San Joaquin Valley Drainage Relief Act, 1992, SB 1669) directly linked to water marketing. The program is intended to be self-supporting once an initial State appropriation provides for farmland purchase. Land retirement and selling of water rights will then provide the funds to sustain the program. Both programs can contribute greatly to recovery of several listed species if operated to solve endangered species recovery and drainage problems as two principal objectives. The nature of the State program makes it most applicable to acquiring smaller, strategic parcels next to natural lands that can provide linkages between larger blocks of natural lands. It could be operated in conjunction with mitigation programs for large-area Habitat Conservation Plans such as for the Metropolitan Bakersfield Area and the Kern County Valley Floor. The Federal program is better suited to creating large blocks of retired farmland within Central Valley Project areas that will support kit foxes (the umbrella species) and populations of associated listed and candidate species and species of concern.

1. Criteria for Federal Land Retirement Program

Drainage Problems and Selenium Contamination.—The Land Retirement Program is being implemented primarily to manage drainage-related problems, including those associated with selenium. Selenium is an naturally occurring element that is highly toxic if levels in the environment and biota become elevated. Contaminant concentrations on retired lands should be monitored to ensure that concentrations are not becoming elevated. To prevent adverse effects to listed species and species of concern in the San Joaquin Valley, the following monitoring and conditions should be met prior to management of these lands for listed species:

a. Determine baseline groundwater conditions of lands being retired at the time of or prior to purchase. Baseline groundwater conditions should include: depth to groundwater and selenium concentration in groundwater.

b. To ensure that biological integrity can be safely maintained on retired lands, a monitoring program should be implemented. The monitoring program should include collection of data on a seasonal basis for: soil salinity, depth to groundwater, groundwater contaminant concentrations (e.g., selenium), groundwater flow paths, contaminant concentrations (e.g., selenium and mercury) in standing water that persists more than 30 days, contaminants (e.g., selenium) in the biota, including invertebrates, small mammals, and kit foxes or coyotes (if present). Groundwater monitoring wells may be needed to assess groundwater movement. This monitoring program should identify the potential for adverse effects to sensitive species and evaluate safety of retired lands for these species. Monitoring data should be compared with the following Land Retirement Program performance standards:

   1) depth to groundwater and selenium concentration in groundwater should not show an increasing trend over 5 years of monitoring;

   2) standing water that persists more than 30 days should not exceed 2 ug/L (parts per billion) selenium and 2 ng/L (parts per trillion) mercury in solution on a total recoverable, unfiltered basis;

   3) mean concentrations of selenium in invertebrates should not exceed 2.5 ug/g (parts per million) on a dry weight basis;

   4) rodent hair concentrations should not exceed 5 ug/g (parts per million) on a dry weight basis or rodent blood concentration should not exceed 0.5 mg/L (parts per million) on a wet weight basis;

   5) blood from kit foxes or coyotes should not exceed 1 mg/L (parts per million) on a wet weight basis.

The monitoring program should be performed for a period of at least 5 years or longer as determined necessary by the USFWS. These data should be provided to the USFWS's Contaminants and Endangered Species Divisions, Sacramento Fish and Wildlife Office, and Realty Division annually for review. Any measures identified by the USFWS necessary for remediation should be implemented including acquiring water for dilution of toxic contaminant concentrations in surface water and ground water.

c. The Service would accept title of retired land only when it has been shown that the performance standards above have been met for 5 years (or as determined by the USFWS's Sacramento Fish and Wildlife Office Contaminants Division). If the performance standards are exceeded for any parcels acquired under the Land Retirement Program, those lands should not be managed as habitat for listed species.

Endangered Species Recovery.—Qualifying criteria for the Federal Land Retirement Program should include endangered species recovery. Currently, the primary criteria qualifying land for retirement are improving water conservation and the quality of agricultural wastewater. Endangered species recovery objectives that should be considered as second order criteria include the following:

a. Retirement of farmland should contribute to recovery of the San Joaquin kit fox and its associated communities. Any potential contaminant issues should be addressed.

b. Land should be retired in blocks instead of scattered parcels. This minimizes "edge" with neighboring farmland and thereby minimizes pest and other problems at the interface between cultivated and natural ground. Blocks should be as large as possible; ideally no less than about 2,023 to 2,428 hectares (5,000 to 6,000 acres). This would provide habitat for three to eight or more families of foxes and contribute to minimizing edge.

c. Blocks ideally should be circular or square in shape. This also minimizes edge.

d. Blocks should be positioned near or within areas with artificial or natural structures serving as potential corridors for movement of kit foxes. The course of Panoche Creek between the edge of the Valley and the natural lands in the Valley's center in Fresno and Madera Counties is one obvious potential corridor. Other potential corridors would be flood-control channels, other dry stream beds, canals, aqueducts, and drainage ditches.

e. Blocks ideally should be connected to natural lands on the western edge of the valley by continuous undeveloped land or other natural movement corridors. This may require purchase and retirement of some lands without serious drainage problems, or substantial enhancement of kit fox habitat on farmlands through a focused safe harbor program.

f. Blocks should contain few or no highways or major roads. Vehicles striking kit foxes are a major cause of their mortality. Large areas with few roads or with only low speed traffic minimize losses.

2. Restoration of Retired Farmland

Given sufficient time, little restoration would be needed to reestablish a natural community providing habitat for kit foxes and other target species. However, to maximize utility for recovery and minimize potential pest problems on neighboring farms, some active restoration is needed:

a. Construction of artificial dens for kit foxes. Successful designs exist.

b. Seeding native barley, and other plants of annual grassland and chenopod scrub communities of the San Joaquin Valley. These are readily available and some seeding will occur naturally. The main objectives would be to provide ground cover to minimize occurrence of major weeds of croplands and reduce soil erosion, and provide cover and food for small animals serving as prey for foxes and raptors.

c. Creating areas of higher elevation to lessen sheet flooding in leveled fields.

d. Retention and planting of additional trees at clustered sites to provide roosting and nesting habitat for raptors.

3. Guidelines for Land Retirement Program

Maximizing success of this proposed Federal retirement program (and the State program) requires developing trust and cooperation of neighboring land owners. A successful program should:

a. Provide exemption from incidental take (take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity) for neighbors. There is precedence for this type of program established by USFWS's Safe Harbor Program for the red-cockaded woodpecker in the Southeastern U.S. (USFWS in litt. 1995*b*). A similar program has been proposed for farmers in the San Joaquin Valley who enhance habitat for listed species (Scott-Graham 1994).

b. Be implemented within an experimental environment where its effectiveness can be adequately assessed and adjustments made, as needed.

G. SUMMARY OF AGENCY AND PUBLIC COMMENTS ON THE DRAFT RECOVERY PLAN FOR UPLAND SPECIES OF THE SAN JOAQUIN VALLEY, CALIFORNIA

I. Summary of the Agency and Public Comment Process

On September 31, 1997, the U.S. Fish and Wildlife Service (USFWS) released the Draft Recovery Plan for Upland Species of the San Joaquin Valley, California (Draft Plan) for a 120-day comment period ending on January 28, 1998, to Federal agencies, state and local governments, and members of the public (60 FR 2155-56). On September 30, 1997, a press release was issued by the Sacramento Fish and Wildlife Office announcing the availability of the Draft Plan for public review, and the dates of a series of Open Houses. Over 700 Draft Plans were distributed to county, State and Federal agencies, libraries, and interested parties. The Open Houses were held to present the Draft Plan to the public, answer questions, and seek written comments. The public Open Houses were held in December of 1997 in three counties within the San Joaquin Valley: Kern, Fresno, and Stanislaus. On February 4, 1998, based on requests from interested groups the public comment period was extended an additional 60 days.

This section provides a summary of general demographic information including the number of letters received from various affiliations. Dr. Katherine Ralls of the Smithsonian Institute, Dr. David Germano of California State University Bakersfield, and Dr. Jay Sheppard, formerly with the U.S. Fish and Wildlife, were requested to peer review the Draft Plan. A complete index of those who commented, by affiliation, is available from the U.S. Fish and Wildlife Service, Ecological Services, Sacramento Fish and Wildlife Office, 3310 El Camino Avenue, Suite 100, Sacramento, California 95821. All letters of comment on the Draft Plan are kept on file in the Sacramento Fish and Wildlife Office.

The following is a breakdown of the number of letters received from various affiliations:

Federal agencies - 6
State agencies - 6
local governments - 2
academia/professional - 10
business industry - 3
agricultural interests - 8
water interests - 4
environmental/conservation organizations - 4

A total of 43 letters were received, each containing varying numbers of comments. Many letters provided suggestions for clarity, most of these suggestions were included in the final plan. Some comments provided new information and some challenged the Draft Plan. New information was included in the final plan if it was important to a recovery task. The remainder of comments were considered, noted, and principal comments were included for response. The following section is a summary of the principal comments and the USFWSs' responses to those comments. We thank all those who commented.

II. Summary of Comments and USFWS Responses

Public Involvement Process

Comment: The USFWS did not follow their own Department of Interior, U.S. Fish and Wildlife Service policies regarding the development of recovery plans and involvement of stakeholders as published in the Federal Register in June, 1994.

Response: The concept of a multispecies recovery plan for the San Joaquin Valley, and the formation of the recovery team predates the Federal Register notice of June, 1994. Beginning in 1996, during the development of the draft, the USFWS began holding meetings with interested parties to discuss major strategies of the Draft Plan. The interested parties included the California Department of Water Resources, the Tulare County Habitat Conservation Plan Advisory Committee, the California Department of Fish and Game, Natural Resource Conservation Service, and species experts.

Comment: A plan of this scope cannot be achieved without the support and participation of both public and private interests.

Response: Beginning in the **Executive Summary** the Plan recognizes the need for public involvement and the need for incentives to encourage this involvement. The Plan recommends the establishment of a regional, cooperative public/private recovery plan implementation team to enlist the participation of all stakeholder groups and interested parties. The **Introduction** acknowledges that if recovery is to be achieved..."trust, partnership, and common purpose must be established amongst government agencies, ranchers, farmers, developers, conservationists, urbanites, and other citizens of the Valley". The following sections of the Plan provide more detail on the way these partnerships will be encouraged; **IV. Stepdown Narrative** (pg. 195-230), **Appendix E. Safe Harbor Programs** (pg. 304-305), and **Appendix F. Retirement of Farmland with Drainage Problems** (pg. 306-308).

Executive Summary

Comment: What were the reasons behind including or excluding certain species from the Draft Plan?

Response: Certain species were excluded from the Draft Plan because they were not listed by the State or Federal government at the time of the Draft Plan's inception (San Joaquin spearscale, big tarweed), or had ranges far beyond the San Joaquin Valley (hispid bird's beak, mountain plover, San Joaquin coachwhip, tri-colored blackbird, southwestern willow flycatcher and yellow-billed cuckoo), or were entire community types that far exceeded the geographic distribution of the featured species (e.g., sycamore alluvial woodland community).

Certain species were included even though questions remain about their genetic makeup because the intent behind including these species was to prevent their being listed which would then necessitate further protection (Bakersfield smallscale, Le Conte's thrasher). Conservation efforts for these species typically includes research into the species genetic makeup, behavior, and geographical distribution. The results of this research will provide the basis for the USFWS's determination as to their uniqueness.

Certain species remain in the Plan, even though during the plan's creation, new evidence indicated that the species was more widespread than was originally thought (Hoover's woolly-star), because they have not yet been downlisted or removed from the endangered species list.

The San Joaquin kit fox and the blunt-nosed leopard lizard were included in the Draft Plan because during the periodic review by the USFWS of their existing recovery plans, the USFWS determined that revisions to those plans were needed. Based on the USFWS's review of both species unstable population status, continuing threats to recovery, and limited achievement of reaching original recovery plan goals, the USFWS determined that these two species warranted inclusion in the Plan.

Comment: Focusing on loss of habitat as the primary cause of species endangerment fails to acknowledge the role that negligence, mismanagement of habitat, and inadequate control of invasive, exotic organisms have played in the degradation of remaining available habitat.

Response: The USFWS recognizes the importance of managing lands for listed species, and does recognize the inadequacy of some previous management programs, however, the USFWS believes that the Plan is built, both on the successes and failures of prior research, directions, and actions. Within the Plan the term "habitat protection" means ensuring appropriate uses of land to maintain and optimize species habitat values.

Comment: Which species do not fall under the San Joaquin kit fox umbrella?

Response: Plant species that are not covered or only partially covered under the San Joaquin kit fox umbrella are the palmate-bracted bird's-beak, Bakersfield cactus, Vasek's clarkia, Temblor buckwheat, Tejon poppy, diamond-petaled California poppy, Merced monardella, and Merced phacelia. Animal species not covered by the kit fox umbrella include the riparian brush rabbit, the riparian woodrat, and certain locations for the three dune beetle species. Specialty reserves have been designated to address the needs of both plant and animal species that are not covered by the kit fox umbrella by virtue of their range or habitat specificity.

Introduction

Comment: Relate this Draft Plan to other plans, current or future, for other listed species which are also found within the San Joaquin Valley.

Response: The table with this information has been inserted into the final Plan as **Appendix D.**

Comment: Define "natural", it is unclear in the text if nonnative grasslands are included in this definition.

Response: Natural lands are those that have not been cultivated in recent years and retain a semblance of the natural community that historically occurred there.

Comment: The Draft Plan does not fully incorporate an ecosystem approach. The Draft Plan should address the numerous other species of concern, all native annual plant species, the interactions of these natives with non-native plant species, and incorporation of other literature covering related species, similar habitats and/or relevant ecological principles and processes, and the negative effect introduced herbivores have had on the native flora.

Response: The commenter suggests a document that would be beyond the scope, policy, and budget of the USFWS. The USFWS has the responsibility under the Endangered Species Act of 1973, as amended (Act), "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, ..." In 1994, the USFWS and the National Marine Fisheries Service issued six joint policies regarding implementation of the Act. The third policy addresses the need to "focus on groups of species dependent on the same ecosystem." It directs the USFWS to "implement recovery plans for multiple listed and candidate species".

Comment: How much of the remaining 5 percent of the San Joaquin Valley, that is not urban or agricultural, would need to be protected to meet the goals of the Draft Plan?

Response: The exact acreage of remaining natural lands on the Valley floor that are needed for recovery cannot be determined at this time. The amount needed will depend on a number of factors, including how successfully public lands are managed, if mechanisms are developed to move kit foxes through existing agricultural land, and the role that other developed lands can contribute to species conservation.

Comment: Provide a brief account of the significant limitations of the GAP Data Set, especially for valley communities, as Figure 3 likely over-estimates *Natural Lands*.

Response: Figure 3 is a generalization of the California Gap Analysis data from the University of California at Santa Barbara. The University's coverage was developed with state and regional level analysis in mind. It does not provide spatial resolution of individual stands of vegetation.

The coverage is considered a draft product subject to revision based on additional field work and review by local experts. The Minimum Mapping Unit for upland sites is 100 hectares (250 acres) and for wetland sites is 40 hectares (100 acres). This resolution was selected by the University in light of the objective to map landscape mosaics rather than individual stands as the appropriate level for protection of biodiversity within the entire state.

Species Accounts

Comment: The Draft Plan does not say how many members of a species need to exist to insure perpetual survival.

Response: It is the USFWS's National Policy to quantify recovery criteria, whenever possible. The Recovery Criteria are discussed in the Plan under section **III. RECOVERY**. The Plan does not specify numbers of individuals for many of the species because their natural behavior makes them difficult to count, and they experience significant natural population fluctuations. Rather, the quantitative criteria are the site-specific protection requirements as listed in Tables 5 and 6. Many of the plant species combine both numbers of individuals and site-specific protection requirements. Some species may have specific research tasks assigned which will assist in quantifying recovery criteria in the future.

Comment: The species accounts need updating.

Response: Many of the species accounts in the Draft Plan were written prior to 1995, the USFWS has updated the portions of species accounts that are necessary to understand or clarify a recovery issue, task, or priority.

Comment: Absent protection of the remaining, undeveloped portions of the Springtown Alkali Sink Preserve watershed, it is unlikely that this population of palmate-bracted bird's-beak will remain stable and viable over the long term.

Response: The USFWS realizes the importance of protecting the integrity of the Springtown watershed and has been actively working with the City of Livermore in protecting the hydrology of the area through the North Livermore General Plan.

Comment: Because Hoover's woolly-star is proposed for delisting, a recovery strategy is not necessary.

Response: The recovery planning process and development of a delisting proposal for Hoover's woolly-star have been progressing simultaneously. Intensive surveys conducted by the U.S. Bureau of Land Management and U.S. Department of Energy in recent years indicate that Hoover's woolly-star is more widespread, abundant, and more resilient to perceived threats than previously thought. This new information suggests that this species may no longer need protection under the Act. Protection of Hoover's woolly-star will be in part through the commitment from the U.S. Bureau of Land Management to "maintain the species in sufficient numbers and distribution such that listing of the species will never again be necessary". This new biological information, together with existing protective measures on public lands, allows the USFWS to consider delisting Hoover's woolly-star. However, because the delisting has not been proposed or finalized at this time, the USFWS must include Hoover's woolly-star in this recovery plan.

Comment: It seems arbitrary and capricious to prescribe recovery criteria for populations that are not known to be declining (such as the foothill populations).

Response: Unlike animals, plants are not listed by population; the entire species is listed. Thus, recovery strategies for Hoover's woolly-star address the entire range of the species. Populations that are not in decline will contribute to recovery without changes in management, whereas declining populations will require more intensive efforts to ensure their long-term conservation.

Comment: It is conjecture that the privatization of the U.S. Department of Energy's Naval Petroleum Reserve #1 could lead to greater surface disturbance if rates of exploration and production are increased.

Response: Increased production is not conjecture, as Occidental Petroleum has already expressed its intent to drill additional wells and conduct exploratory activities throughout Elk Hills. Although low-to-moderate levels of petroleum production appear to be compatible with the continued existence of Hoover's woolly-star and other listed species, there is no evidence that high-density oil fields maintain suitable habitat over the long-term.

Comment: The species account for the Bakersfield smallscale does not clearly indicate the presence of a resident population at the Kern Lake Preserve nor does subsequent discussion clearly indicate Bakersfield smallscale as a separate species.

Response: These have been clarified in the final version of the Plan.

Comment: Based on the community associations described in the species account, the East Bay Regional Park District suggests that there are four suitable sites for recovery of the diamond-petaled California poppy in the East Bay (Black Diamond Mines Regional Preserve, Roddy Ranch, Los Vaqueros Watershed, and in the Altamont Creek watershed).

Response: The USFWS appreciates the interest of the East Bay Regional Park District in the conservation of the diamond-petaled California poppy, and has included those sites in Table 3 and the *Conservation Strategy* section.

Comment: In regard to protection of lands, those lands currently occupied by giant kangaroo rats should receive priority over lands that are not currently occupied by the species (pg 91, item c should be moved to the bottom of the list).

Response: The giant kangaroo rat has intermittently occupied these periodically-farmed areas in western Fresno and eastern San Benito Counties. Protecting these lands could allow the giant kangaroo rat to expand in that area. For this reason, these lands are considered to be a higher priority than the smaller, fragmented populations in the Cuyama Valley, Kettlemen Hills, or San Juan Creek Valley.

Comment: No mention is made in the Draft Plan about the effect of the California ground squirrel on the giant kangaroo rat.

Response: There is some evidence that the California ground squirrel may displace the giant kangaroo rat, however, this is usually on a temporary basis, and over the long-term, has not significantly affected this species.

Comment: Provide an estimate for the number of hectares that historically would have been suitable habitat for the Fresno kangaroo rat.

Response: An accurate estimate of the amount of historical Fresno kangaroo rat habitat cannot be calculated. There has been a long history of land conversion in the range of the Fresno kangaroo rat, 140 to 150 years in some cases. Also, the subspecies range did include wetlands and other natural communities that did not support Fresno kangaroo rats. Our best guess is that a significant portion of the historical range (probably 50 to 70 percent) was suitable habitat.

Comment: If the San Joaquin kit fox preys on listed kangaroo rat species, why is there no mention of controlling the San Joaquin kit fox through a predator control effort.

Response: Because the San Joaquin kit fox is an endangered species, predation by kit foxes on kangaroo rats is not likely to be a significant limiting factor on kangaroo rat populations, and, therefore, controlling kit fox numbers would be unsound.

Comment: There is no mention of recent genetics work which tends to lump Tipton kangaroo rats and short-nosed kangaroo rats, but supports the subspecies division relative to short-nosed and Fresno kangaroo rats.

Response: The genetic studies referred to by the commenter have not been completed at this time, therefore, it is premature to speculate about their conclusions. Because of the extreme difficulty of finding Fresno kangaroo rat populations in their primary historic range, researchers have been required to use museum specimens. Thorough analyses of these specimens is a lengthy process.

Comment: The blunt-nosed leopard lizard had a previous recovery plan, can the successes and failures be quantified, particularly with regard to acreage.

Response: The original recovery plan for the blunt-nosed leopard lizard was written in 1980. The prime objective of the 1980 recovery plan was to restore and maintain blunt-nosed leopard lizard populations at or above the 1979 levels. This included determining distribution of the lizard on both public and private lands, monitoring land use changes and population changes, investigating effects of insect and rodent control programs, and preserving specific "units" of habitat (through lease, fee title, purchase, easement, landowner agreement or zoning).

The recovery plan designated twenty "Habitat Units" as "essential", giving 10 of those priority for protection. The 10 areas equaled 150,000 acres of private lands. The recovery plan determined that in addition to the public lands designated as essential, 30,000 acres of the 150,000 acres of private land would need to be preserved to delist the blunt-nosed leopard lizard. To date less than 10,000 acres of the designated 150,000 acres has been preserved, however, an estimated 74,144 acres have been lost.

In addition many other goals of the 1980 recovery plan have not been met. For example, the effects of oil and gas operations on blunt-nosed leopard lizards were not evaluated to the extent that they were for the kit fox.

Comment: Clarify if blunt-nosed leopard lizards occupy ground squirrel burrows, the text is confusing.

Response: They inhabit both antelope squirrel and California ground squirrel burrows.

Comment: San Joaquin kit fox had a previous recovery plan. Can the successes and failures be quantified?

Response: In the 1983 Recovery Plan for the San Joaquin kit fox, six Recovery Tasks were proposed. The first was to reduce or reverse the rate at which habitat of the kit fox is being lost by initiating a program of essential habitat management, protection, and acquisition. Although no specific "program" was initiated, there was a coordinated effort by agencies and nonprofit organizations to acquire and manage lands for this purpose. The goal was to protect a total of 25,000 acres in western Kern County and the Carrizo Plain in eastern San Luis Obispo County. To date, the target has been met only for the Carrizo Plain.

The second task was to acquire additional information necessary to understand the ecological life history requirements of the kit fox and to determine their compatibility with human activities such as petroleum field developments, grazing, rodent control programs, and agricultural expansion. Many research programs were developed in the intervening years to answer just such questions. As of 1983 there were only 13 documents with information on the San Joaquin kit fox. Today there are hundreds of papers, either published in technical journals or as reports to agencies. The U.S. Department of Energy and the California Energy Commission both conducted multiple year research into the effect of differing oil production levels on a variety of kit fox natural history aspects. The U. S. Department of the Army conducted similar studies with regard to the effects that military exercises would have on kit foxes. Recently the Endangered Species Recovery Program began studying the use of agricultural lands by kit foxes, and grazing research undertaken by the U.S. Bureau of

Land Management and the U.S. Geologic Survey will provide insights into the effects of grazing on kit fox prey abundance. Recent work on urban kit fox population ecology in Bakersfield is shedding new light on the potential for this population to contribute to recovery. No specific research has been conducted on the effects of different rodent control programs on the San Joaquin kit fox.

The third task was to restore degraded essential habitats by enhancing natural routes and rates of vegetation. Although much of the land protected under task 1 has been managed for San Joaquin kit fox, it has not reached or retained the goal of 1.4 adult kit foxes per acre.

Task four was to monitor progress of recovery by determining changes in kit fox distribution and abundance, habitat losses or gains, rates of habitat restoration, and acquisition of new information concerning kit foxes. Unfortunately, as is mentioned in the Plan, there has not been a range wide survey to determine kit fox distribution and abundance. Individual monitoring programs do provide yearly data on local distribution and abundance. In part, due to this yearly information, it became clear to the USFWS that the 1983 Recovery Plan for the kit fox needed to be revisited and updated, hence the inclusion of the kit fox in the Plan.

The fifth task was to investigate the feasibility of reintroductions in portions of the original range of the kit fox. Minimal research has been conducted on this task.

The sixth task was to develop strategies for integrating Recovery Plan objectives into development and management goals for the southern San Joaquin Valley. As mentioned in the Plan there has been, and continues to be, much progress on this task. Habitat Conservation Plans, Biological Opinions, and Resource Management Plans, all take into account goals for kit fox recovery.

Comment: It is unclear from the Draft Plan whether the concern is that there is inadequate information to determine if enhancement of farmland habitat for wildlife will benefit the nonnative red fox over the San Joaquin kit fox, or whether it is established that enhancement activities for the kit fox would also benefit the red fox. If enhancement activities would also benefit red fox, then red fox control will have to be an integral part of the overall recovery strategy.

Response: The Endangered Species Recovery Program is currently studying the use of agricultural land by both species. Results of this study will guide the direction of management. Any red fox control program would need to be done in a selective manner.

Comment: Not provided is any justification for the need, location, and width of the actual linkage corridors for the San Joaquin kit fox shown on Figure 73.

Response: The Plan does discuss the need for linkage corridors, and the general locations are indicated on Figure 73. Specific locations, within the larger general area, and the eventual width and shape of the linkage corridors is dependant on the amount of state and federally owned land, the amount of natural lands, and the willingness of landowners to voluntarily enter into cooperative agreements to preserve natural lands or to reestablish habitat on retired farmland.

Comment: Fort Hunter Liggett has a very small population to be considered "important" (no foxes sighted in the last 2 years and fewer than a dozen known on post at any given time). Camp Roberts populations are also at extremely low levels and possibly below the necessary number required to recover. Additional recovery efforts may be needed here, including determining why the fox population is declining, and considering a reintroduction program for these two sites.

Response: This information has been taken into account and necessary adjustments made in the final Plan.

Comment: In the San Joaquin kit fox **Population Ecology and Management** section, what does "fluctuations in vital rates and spatial parameters of populations" mean. (pg. 133, within v.)?

Response: Fluctuations in vital rates and spatial parameters of populations refers to population demography, including reproduction, mortality, survivorship, recruitment into the population and dispersal. These are basic parameters of population ecology.

Comment: Another measure that should be considered under the San Joaquin kit fox **Population Ecology and Management** section, is to study the persistence and demographics of kit foxes in urban areas such as Bakersfield. Protection measures for foxes in urban areas should also be developed and implemented.

Response: This information has been taken into account and necessary adjustments made in the final Plan.

Comment: The Draft Plan may only provide limited protection for the dune community insects and it is not clear by what method the number of protected sites, acreages, and locations were chosen.

Response: Locations highlighted in the Plan are sites where populations of the dune community insects are known to occur. If additional populations are found, the USFWS will pursue incentives for conservation.

Comment: Due to the low numbers of riparian brush rabbits, has the USFWS considered an artificial breeding recovery program in which individuals trapped in the future would be added to the breeding program?

Response: The dangerous decline in riparian brush rabbit numbers has been a result of the last few years of extensive and persistent flooding. Adjustments have been made in the final Plan to respond to the urgent needs of this species.

Recovery

Comment: The Draft Plan should make clearer that the goal of any recovery plan is to recover the species, not just to reclassify the listed status.

Response: Within the **OBJECTIVES** of Section **III. RECOVERY**, the Plan states that the overall objectives of this recovery plan are to delist the federally listed species. Downlisting from endangered to threatened is usually the first step in the delisting process. This reclassification is an indicator that "the species is on the road to recovery", however, protection afforded by the Endangered Species Act is still in effect. This protection remains in place until the best scientific and commercial data available indicate that protection is no longer needed for the species' long-term survival.

Comment: It is not clear in Table 4 ***Generalized Recovery Criteria for Federally-Listed Plants and Animals***, whether or not the required protected recovery areas overlap with other species requirements or if the acreage of each species is additive to the overall requirement of the Draft Plan.

Response: Table 4 provides information for delisting for each individual species. If listed species overlap in their locations, the acreage's would not be additive. The species with the lower acreage would, therefore, be included in the larger acreage as long as the other criteria, such as occupation, were met. These acreage amounts are also not additive to the "overall requirement", they are the pieces of the overall requirement.

Comment: The Draft Plan fails to adequately describe the "site specific management actions" that may be "necessary to achieve the plan's goal for the conservation and survival of the species" (16 U.S.C. § 1533(f)(1)(B)(i)).

Response: Areas in need of protection have been identified in Tables 5 and 6. Site specific management actions have been addressed where possible, and where not addressed, specific management actions will be tailored to the area once the identified management related research tasks are completed (see Table 10).

Comment: The Draft Plan fails to describe "objective, measurable criteria" which "would result in a determination...that the species be removed from the list" (16 U.S.C. § 1533(f)(1)(B)(ii)).

Response: It is the USFWS's National Policy to quantify recovery criteria, whenever possible. The Recovery Criteria are discussed in the Plan under section **III. RECOVERY**. The Plan does not specify numbers of individuals for many of the species because their natural behavior makes them difficult to count, and they experience significant natural population fluctuations. Rather, the quantitative criteria are the site-specific protection requirements as listed in Tables 5 and 6. Many of the plant species combine both numbers of individuals and site-specific protection requirements. Some species may have specific research tasks assigned which will assist in quantifying recovery criteria in the future.

Comment: The Draft Plan fails to provide "estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal (16 U.S.C. § 1533(f)(1)(B)(iii)).

Response: See the **Implementation Schedule** for estimates of the time required to carry out each recommended task and the cost to carry out each task, where costs can be estimated.

Comment: Will the Draft Plan add an additional layer of mitigation and or compensation requirements on top of requirements called for in existing Habitat Conservation Plans?

Response: Existing Habitat Conservation Plans were developed with listed species recovery and candidate species protection in mind. In many instances Habitat Conservation Plans are the cornerstone of protection strategies within the Plan. A fundamental aspect of Habitat Conservation Plans is that they cannot preclude recovery, and in many cases, such as the Kern Water Bank Habitat Conservation Plan, help the USFWS reach recovery goals. Therefore, there would be no new mitigation or compensation requirements from these existing Habitat Conservation Plans.

Comment: The Draft Plan states that monitoring showing stability or increasing numbers during a precipitation cycle (annual rainfall of 35 percent above-average through greater than 35 percent below-average and back to average or greater) would achieve population goals. How was this criterion for achieving population goals arrived at?

Response: Although basing population assessments on a precipitation cycle of plus or minus 35 percent of average precipitation is somewhat arbitrary, it recognizes the tremendous environmental variability in the San Joaquin Valley and the significant impacts this variability has on population dynamics of plants and animals. This extreme variability (which is normally affected through timing and amount of rainfall) is a fact, as is the impact it has on San Joaquin ecosystems. Sufficient information is currently unavailable to refine this criterium. This is an area that needs further research.

Comment: The Draft Plan incorrectly refers to natural habitat and historic ranges of upland species in areas that were actually the historical Tulare Lake, and therefore a historical wetland. Restoration efforts should be driven by what occurred on the site historically and should not be permanently hampered by protection efforts driven by what occurs on the site currently.

Response: The USFWS recognizes the importance of wetland restoration in the San Joaquin Valley. Wetland restoration that provides a full complement of the factors needed by wetland species should include an upland component. This upland component can benefit upland federally listed species as well.

Comment: Small preserves should not be limited to specialty preserves, but for all species, to protect from disease, potential genetic disorders, and invasion of exotic species or predators.

Response: The Plan does not exclude small preserves and some of the identified research tasks will help determine the size, shape, and locations of these preserves for the reasons presented by the commenter.

Comment: How much private land will be needed to recover these species?

Response: The USFWS cannot estimate the acreage of private land that will be needed to recover listed species included in this recovery plan. Wherever possible, the recovery plan first emphasizes using public or other conservation lands to achieve recovery goals.

Comment: The reliance on the "Safe Harbor" concept to recover certain species in the Draft Plan will not work because Safe Harbor agreements do nothing to reduce the chief source of liability for neighboring agricultural landowners: incidental take of species in the course of otherwise lawful, routine, and ongoing agricultural practices on lands in active agricultural use. Clearly, such a limited "harbor" provides no safety whatsoever to an agricultural landowner.

Response: The commenter appears to be concerned about two issues—the effects of the Endangered Species Act's (Act) "take" prohibition on agricultural lands and producers generally; and (2) specifically, the effects of the Act's take prohibition on lands neighboring properties subject to a Safe Harbor agreement. With respect to number (2), landowners that neighbor Safe Harbor programs may have legitimate fears that habitat creation or restoration under such programs could result in regulatory restrictions on their own lands (if, for example, endangered species on the Safe Harbor lands colonize a neighboring property). The USFWS shares this concern and is exploring mechanisms to protect neighboring landowners, as well as the landowner enrolled in the Safe Harbor program, under its national Safe Harbor policy. The USFWS also shares the concern expressed under number (1) above—that the Act's take prohibition may result in violations of the Act if endangered species are inadvertently taken during routine agricultural operations, such as plowing fallowed land. However, this is a broader issue that exceeds the scope of the Safe Harbor program and is best addressed under the Habitat Conservation Planning program.

Comment: The Draft Plan does not recognize the cumulative impact on the San Joaquin Valley economy of other species protection set-asides in place or in planning at this time, including the demands of the massive CALFED process which threatens to retire more than 250,000 acres of some of the best farmland in the nation — within the recovery planning area— to offset impacts traceable in large measure to growth outside this area. It is poor environmental planning to retire agricultural acreage if feasible alternatives exist.

Response: Land Retirement is a program authorized under use Central Valley Project Improvement Act (CVPIA (§3408(h)). The primary objective of the Land Retirement Program is to decrease drainage-related problems caused by selenium along the central and western side of the San Joaquin Valley. The land is purchased from willing sellers and is intended to retire lands that are no longer suitable for sustained agricultural production. These lands have permanent damage resulting from severe drainage or agricultural wastewater management problems, groundwater withdrawals, or other causes.

There are many advantages to retiring these damaged and impaired lands. Certain lands retired may be restored to benefit listed upland species helping to meet recovery goals. Retirement of seleniferous lands and restoration for endangered species can be a cost effective method of overlaying two Federal programs lessening the burden on private landowners. By reducing saline and toxic drainage, land retirement can lead to an improvement of water conservation by water districts or improve the quality of an irrigation district's agricultural wastewater. Safer water can potentially benefit fish and wildlife, and associated habitats in the Central Valley. Many land owners are receptive to the program—for example, advertisements in local newspapers, organizational newsletters, and agricultural publications resulted in the receipt of 31 applications covering approximately 27,582 acres, of which 12,563 acres were selected.

It should be stated that recovery plans are advisory documents and not action documents. Implementation of recovery tasks is discretionary. Therefore, recovery plans do not require, as do National Environmental Policy Act (NEPA) documents, an analysis of the cumulative impacts of recovery implementation. Specific Federal actions that implement recovery tasks might be subject to such analysis.

Currently the CALFed project does not include a land retirement program.

Comment: Perpetual conservation easements or transfer of fee title to a conservation entity constitutes a "taking" of private properties if it is done without any accompanying compensation.

Response: Perpetual conservation easements are purchased from willing sellers at fair market value or received as donations. Transfer of fee title also occurs when landowners willingly sell or donate land. The USFWS, therefore, is not "taking" land.

Comment: Discussions pertaining to the Kern Lake Preserve presented within the Draft Plan present the impression that private landowners are incapable of administering recovery programs or maintaining sensitive habitat areas.

Response: The USFWS recognizes and appreciates that the landowner has protected, to date, the Kern Lake population of the Buena Vista Lake shrew. However, there are factors outside of the landowner's control that may affect this population. Without an agreement for the conservation of this candidate species, its protection is not guaranteed.

Comment: The number of "specialty preserves" is unusually high in Kern County relative to other portions of the plan area.

Response: Kern County has a higher proportion of natural lands remaining on the Valley floor than do most other counties included in the plan area. Not coincidentally, threatened and endangered plants have persisted in Kern County. Many of these plants, additionally, have limited distribution.

Comment: Now that the Naval Petroleum Reserve in California # 1 is in private ownership, the Draft Plan does not adequately identify procedural steps and funding appropriate to designate the Elk Hills Unit as a "core area".

Response: The purpose of a recovery plan is to identify areas needing preservation. The mechanism to preserve the area should be determined by agencies and the landowner.

Comment: It is very likely that pesticide concerns and some of the proposed research can be addressed with existing information on file at the Department of Pesticide Regulation.

Response: The USFWS will use all appropriate sources of information when carrying out recovery tasks.

Comment: The claim that pesticides are a potential threat to pollinators of native plant species is not credible at face value.

Response: The USFWS continues to believe that insecticides are a potential threat, given that they kill insects and insects are believed to pollinate many of the plant species included in this Plan. Dr. Robbin Thorp, professor emeritus at the University of California, Davis, and a highly respected expert on native insect pollinators, supports USFWS's concerns regarding the potential threat of insecticides. The Plan does not state that insecticides or other pesticides are a documented threat but rather that they are a potential threat. It recommends further research to determine whether or not pesticides pose a problem, and under what conditions their use is compatible with recovery of these species. The efforts of the California Department of Pesticide Regulation to strengthen existing protections, by prohibiting use of certain insecticides when listed plants are in bloom, is a positive step toward protecting these rare plants until research on this matter can be conducted.

Comment: Many of the efforts outlined in the Draft Plan that will be necessary to recover species are in progress or have at least been initiated.

Response: The Plan, which has been developing over the last 6 years, has already provided many agencies and organizations a direction in planning research projects and in targeting specific areas for purchase that will meet recovery tasks. There are at a minimum three research projects underway that will begin to answer questions about San Joaquin kit foxes, and the direction provided in early versions of the Draft Plan allowed the Metropolitan Bakersfield Implementation Trust group to target specific areas for the protection of Bakersfield cactus, bringing recovery goals ever closer.

Comment: Some areas mentioned in the Draft Plan, like Devil's Den, Lost Hills, Caliente Creek, Cuyama Valley, and Poso Creek are currently slated by the U.S. Bureau of Land Management to be exchanged. These areas could very likely move into private ownership. How will this change the Draft Plan?

Response: The geographic areas listed by the commenter fall within the U.S. Bureau of Land Management Caliente Resource Management Plan (RMP) area. The U.S. Bureau of Land Management RMP General Management Processes require that all proposed actions, including land exchanges, be reviewed for compliance with the National Environmental Policy Act, Endangered Species Act, and other laws. If it is determined that a proposed land exchange may affect a listed species, the U.S. Bureau of Land Management must consult with the USFWS under section 7 of the Endangered Species Act.

Comment: Define the terms and any legal significance of "Management Plan", "survival of the species as an objective", and "identified as essential to continued survival".

Response: There is no legal significance to any of the above terms. A Management Plan is a document that states the management objectives for a specific site and identifies the actions to be taken to achieve those objectives. "Survival of the species as an objective" means that the management plan should specify that promoting the continued existence of species covered in this Plan is an objective. "Identified as essential to continued survival" referred to the areas specified in the **Recovery and Stepdown Narrative** sections of the Plan (sections III and IV, respectively) that are needed to achieve recovery. To avoid confusion with legally designated critical habitat, the final Plan refers to these as "important to the continued survival".

Stepdown Narrative

Comment: The Draft Plan should present strategies to secure funding to promote local government Habitat Conservation Plan efforts.

Response: In section 6. (d) of the Act, the USFWS is "authorized to provide financial assistance to any State, through its respective State agency... to assist in the development of programs for the conservation of listed species or to assist in monitoring the status of candidate species... and recovered species". These funds are allocated on an annual basis. In 1997 and 1998, money was appropriated by Congress, through section 6 of the Act, to assist local entities with Habitat Conservation Plan implementation.

Implementation Schedule

Comment: The Implementation Schedule lacks sufficient detail in addressing the specific source of funding, and lacks the assurances that the responsible parties such as State and Federal agencies will actually implement the recovery strategies.

Response: The USFWS can not assure that state or other Federal agencies will implement the recovery plan. Congress appropriates funds to the USFWS for endangered species activities, and the USFWS funds the implementation of recovery tasks after evaluating all of its work load priorities. The USFWS cannot guarantee that sufficient funds will be available to implement this or any other recovery plan.

Comment: The Implementation Schedule is for the first 4 fiscal years only, yet the Draft Plan is for 20 years. How will the costs be allocated for the next 16 years?

Response: The Total Cost column reflects costs over 20 years. Only the first 4 years are shown in detail because they represent a more precise budget cycle. For ongoing continual tasks the costs in years 5 through 20 would be the same or similar to years 1 through 4.

END

04-22-99